

Age Determination and Some Population Characteristics of Chub (*Squalius cephalus* L., 1758) in the Çamlıdere Dam Lake (Ankara, Turkey)

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Abstract

Reliable bony structure for age determination and some population characteristics of chub (*S. cephalus* L., 1758) from the Çamlıdere Dam Lake were investigated. Different bony structures such as scale, vertebra and otolith were removed from all specimens for age determination and interpreted by three times, independently. Sex composition of population was 71.3% female and 28.7% male. The fork length and weight of specimens ranged 18.5-35.3 cm and 124.40-667.57 g, respectively. The von Bertalanffy growth equations were found as $L_t = 38.51[1 - e^{-0.328(t+1.67)}]$ for females and $L_t = 34.12[1 - e^{-0.371(t+1.07)}]$ for males. Length-weight relationships were estimated as $W = 0.0131FL^{3.0434}$ for females, $W = 0.0142FL^{3.0186}$ for males and $W = 0.0138FL^{3.0276}$ for all individuals.

Key words: Chub, *Squalius cephalus*, Çamlıdere Dam Lake, Turkey

Çamlıdere Baraj Gölü (Ankara, Türkiye)'ndeki Tatlı Su Kefali (*Squalius cephalus* L., 1758)'nin Yaş Tayini ve Bazı Populasyon Özellikleri

Özet

Çamlıdere Baraj Gölü'nden tatlısu kefalinin (*S. cephalus* L., 1758) yaş tayini için güvenilir kemiksi yapısı ve bazı populasyon özellikleri incelenmiştir. Yaş tayini için tüm bireylerden pul, omur ve otolit gibi farklı kemiksi yapılar alınmış ve bağımsız şekilde üç kez yorumlanmıştır. Populasyonun eşey kompozisyonu %71,3 dişi ve %28,7 erkektir. Örneklerin çatal boyları 18,5-35,3 cm, ağırlıkları 124,4-667,57 g arasında dağılmaktadır. von Bertalanffy büyüme denklemi dişilerde $L_t = 38,51[1 - e^{-0,328(t+1,67)}]$, erkeklerde $L_t = 34,12[1 - e^{-0,371(t+1,07)}]$ olarak belirlenmiştir. Boy-ağırlık ilişkisi dişilerde $y = 0,0131x^{3,0434}$; erkeklerde $y = 0,0142x^{3,0186}$ ve tüm bireylerde $y = 0,0138x^{3,0276}$ olarak tespit edilmiştir.

Anahtar Kelimeler: Tatlı su kefalı, *Squalius cephalus*, Çamlıdere Baraj Gölü, Türkiye

1. Introduction

Chub (*Squalius cephalus* L., 1758) is one of the most common and widely distributed Cyprinid species in Europe, Anatolia, Black and Azov Sea basins [1,2]. Age, growth, feeding, length-weight relationships and reproduction features of the chub inhabiting European and Turkish waters have been reported [3-20]. But there is no substantial information on the biology of chub in Çamlıdere Dam Lake (Turkey). This study is the first record on basic biological characteristics such as age, growth, condition factor, length-weight relationship *S. cephalus* in Çamlıdere Dam Lake.

2. Material and Method

The Çamlıdere Dam Lake was constructed between 1976 and 1985 by Turkish State Water Systems Services (DSI) on the Bayındır Stream [21]. This lake is alkaline and its pH change between 6.4 and 8.3. According to morphometric and edaphic factors, the lake can be interpreted by as mesotrophic [22].

Samples were collected from commercial fisherman between June and August 2006 from the Çamlıdere Dam Lake. All specimens (n=101) were measured to the nearest millimeter in fork length (FL) and to the nearest gram in weight (W). Sex was determined by macroscopic observation

of the gonads. For age determination, three hard structures (scales, otoliths and vertebrae) were removed from individuals and cleaned by appropriate procedures [23]. Age determinations were done with three independent readings. Accuracy of repetitive readings was evaluated by percentage agreement for assigned age among the first, second, and third readings by the one reader. In addition, the average percentage error (APE) was used to assess consistency in repeated age determinations [24]. The APE for all bony structures were estimated as follows:

$$APE_j = 100\% \frac{1}{R} \sum_{i=1}^R \frac{|x_{ij} - x_j|}{x_j}$$

where APE_j is the APE of the age estimate for a single fish (jth fish).

The von Bertalanffy growth parameters, length-weight relationships, and the Fulton's condition factors (CF) were calculated by using the formula for female, male and combined sexes [25].

$$W = a * L^b$$

$$CF = (W/FL^3) * 100$$

$$L_t = L_{\infty} (1 - e^{-K(t-t_0)})$$

where L_t is the length of fish in cm at age t , L_{∞} is the asymptotic length of the fish in cm, e is the base of natural log (2.71828) t is the fish age (year), t_0 is the hypothetical time at which the length of the fish is zero, K is the rate at which growth curve approaches the asymptote.

3. Results and Discussion

A total of 101 chub individuals was collected from Çamlidere Dam Lake during the study period. Sex composition of population was 71.3% female and 28.7% male. The fork length and weight of specimens ranged from 18.5-35.3 cm to 124.40-667.57 g, respectively. However, the difference between fork lengths of female and male was not significant ($P > 0.05$).

Different structures from the same chub often did not give the same age estimates. For all structure comparisons (Table 1), the highest agreement among three readings was determined in scale (96.6%) and the lowest in vertebra (78.1%).

Furthermore, bony structures with the lowest APE was scale (4.3%) and the highest was vertebra (8.2%). Certainly, the ageing structure having the lowest APE and highest agreement are preferred as an ageing material. According to scale reading, the specimens ranged in age from I to VI years for females, from I to V for males. The most dominant age group was II for both females and males (Fig. 1).

The von Bertalanffy growth equations calculated by using mean fork lengths at different ages, were found as $L_t = 38.51 [1 - e^{-0.328(t+1.67)}]$ for females and $L_t = 34.12 [1 - e^{-0.371(t+1.07)}]$ for males. Females grew to a greater asymptotic length (L_{∞}) than the males.

Length-weight relationships were calculated for each sex and the whole sample were summarized in the following equations:

$$W = 0.0131FL^{3.0434} \quad r^2 = 0.93 \quad \text{for females,}$$

$$W = 0.0142FL^{3.0186} \quad r^2 = 0.94 \quad \text{for males and}$$

$$W = 0.0138FL^{3.0276} \quad r^2 = 0.91 \quad \text{for all individuals.}$$

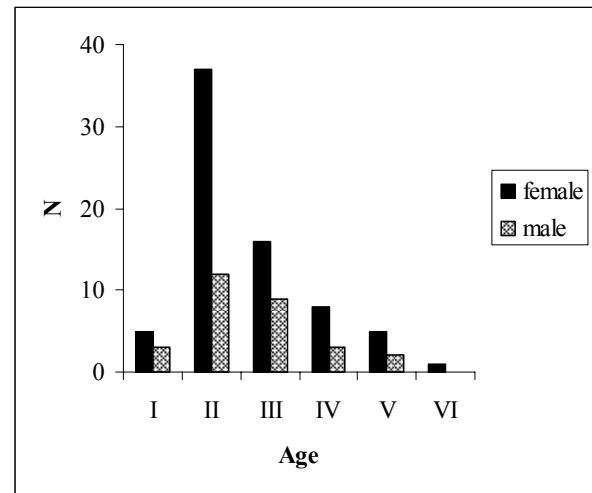


Figure 1. Age and sex distribution according to scale reading of *S. cephalus* samples captured in the year 2006 from Çamlidere Dam Lake.

The correlation coefficients of these equations for females ($r^2=0.93$) and males ($r^2=0.94$) were close to one. The value “ b ” of females was higher than males. The length-weight curve for all individuals are plotted in Fig. 2.

Table 1. The values of precision and average percent error (APE) of reader on different bony structures for chub.

Structure	n	% of full agreement	APE	
			(%)	SE
Scale	101	96.6	4.3	0.3
Vertebra	101	78.1	8.2	0.5
Otolith	101	79.7	6.9	0.4

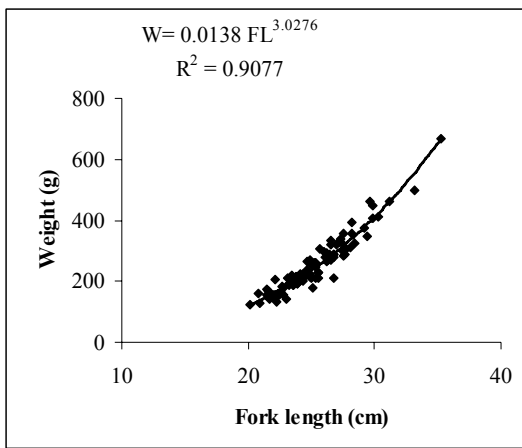


Figure 2. Relationship between fork length and weight of *S. cephalus* for both sexes.

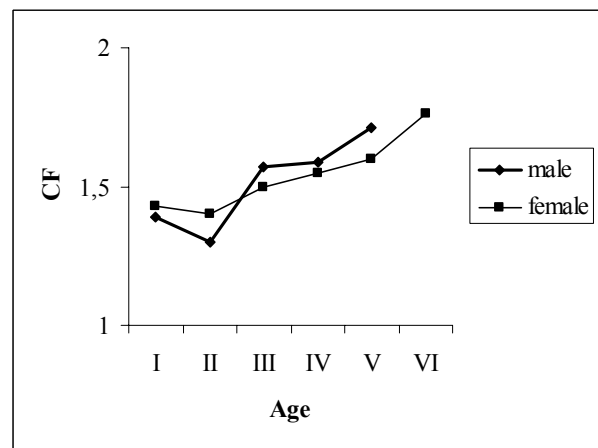


Figure 3. Mean condition factor according to age and sex of chub.

The mean condition factors according to sexes at different ages are represented in Fig. 3. The mean condition factor of females (1.54) was higher than that of males (1.51), but the differences between condition factors of females and males were not statistically significant ($P > 0.05$). Fig. 3 shows that the condition factors increase with age.

Age data represent valuable information concerning the life history of a fish species; however, reliability of the age determination largely depends on interpretation of the growth zones on the bony structures [26]. The values of the index of average percent error for scale was low (4.3%), indicating the goodness of the ageing procedure a reasonable reproducibility between readings.

According to scale reading, the specimens ranged in age from I to VI years for females, from I to V for males. The fact that 80.55% of female and 83.58% male specimens were between ages I and III indicates that the population were mostly young individuals. The most dominant age group in the population was II for both females and males (Fig. 1). This situation was also reported for Işıklı Lake, Divanbaşı Pond, Aras River, Karasu River, populations in Turkey [13, 20, 27, 28] and Iskar River, Bulgaria [29]. It is reported that, most of the samples were in the third age group for Topçam, Karakaya, Almus and İkizcetepeler Dam Lake populations [9, 15, 18, 19].

Length-weight relationship data obtained for *S. cephalus* inhabiting the different area in Turkey have been showed in Table 2. For Çamlıdere Dam Lake, the slope (b) values of the length-weight relationship in both sexes ($b = 3.04$

Table 2. Summary of the available parameters of length-weight relationship, growth (L_{∞} , K , t_0) and condition factor (CF) of chub for Turkish populations. (a and b: parameters of the length-weight relationship. r^2 : coefficient of determination) * for all specimens

Area	Sex	n	Weight (g)	Length (cm)	a	b	r^2	L_{∞}	K	t_0	CF	Ref.
Tödürge Lake	♀	460	*	*	0.010	3.10	-	47.4	0.11	- 0.38	0.81	[8]
Aras River	♂	214	1.5-347.1*	5.3-29.9*	0.012	3.04	-	54.5	0.08	- 0.75	1.07	
Topçam Dam Lake	♀	558	3.0-302.5	6.3-27.5	0.009	3.14	0.98	36.7	0.11	- 1.39	1.08-1.46	[27]
Sır Dam Lake	♂	533	4.2-181.5	6.7-24.1	0.010	3.11	0.96	32.5	0.12	- 1.63	1.25-1.52	
Işıklı Lake	♀	242	19.8-344.0	10.8-26.2	0.009	3.19	0.955	40.2	0.12	- 1.58	1.41-1.91	[9]
Karakaya Dam Lake	♂	90	16.2-203.1	9.7-23.5	0.023	2.85	0.947	27.1	0.30	- 0.46	1.78-1.74	
Almus Dam Lake	♀	234	20.51-2242	11.6-51.3	0.0074	3.17	-	74.0	0.17	- 0.82	1.25-1.60	[14]
Çamlıdere Dam Lake	♂	191	26.18-1556	11.2-46.2	0.0063	3.21	-	54.0	0.30	- 0.49	1.18-1.51	
İkizcetepeler Dam Lake	♀	215	44.6-247.0	13.5-23.1	0.014	3.08	0.949	28.6	0.17	- 3.32	1.40-2.00	[13]
Çamlıdere Dam Lake	♂	313	41.7-260.1	13.5-23.0	0.016	3.03	0.943	31.6	0.03	- 3.84	1.57-2.14	
Çamlıdere Dam Lake	♀	49	123.8-721.5	17.0-36.2	0.013	3.03	-	37.8	0.41	- 1.00	1.42	[15]
Çamlıdere Dam Lake	♂	28	115.4-584.2	17.0-34.4	0.082	2.49	-	35.5	0.60	- 0.19	1.43	
Çamlıdere Dam Lake	♀	178	41.0-668.0	14.7-34.0	0.005	3.27	-	39.11*	0.162*	- 3.05*	-	[18]
Çamlıdere Dam Lake	♂	127	35.6-408.4	14.0-31.0	0.053	3.27	-				-	
Çamlıdere Dam Lake	♀	172	18.6-243.6	11.1-24.8	0.023	2.87	0.90	28.89	0.224	- 1.55	0.77-2.40	[19]
Çamlıdere Dam Lake	♂	242	29.3-173.9	12.2-24.1	0.019	2.92	0.889	26.71	0.259	- 1.55	1.30-2.03	
Çamlıdere Dam Lake	♀	72	151.9-667.6	21.5-35.3	0.013	3.04	0.93	38.51	0.328	- 1.67	1.38-1.99	This
Çamlıdere Dam Lake	♂	29	124.4-462.6	20.0-31.2	0.014	3.01	0.94	34.12	0.371	- 1.07	1.27-1.91	study

for females, $b = 3.01$ for males) showed that weight increased with length in positive allometry. It is seen that “ b ” values varied from 2.49 (in Karakaya Dam Lake, [15]) to 3.21 (in Sır Dam Lake, [14]) and it is determined that there was a significant differences ($P < 0.05$). The b values for the same species on different country populations are shown in Table 3. As seen in Table 3, b values for the 8 European ecosystems (except Turkey) varies from 2.670 (in Lika River, Croatia, [7]) to 3.856 (in Strymon Estuary, Greece, [11]). Part of the difference could be due to the use of different length measurements among researchers (e.g. total instead of fork or standard length). It is known that geographic location, environmental condition, stomach fullness, disease and parasite loads can effect length-weight relationship [25]. Mean condition of specimens as well as the difference in condition between small and large specimens according to seasons, localities and years, resulting in different length-weight relationships [30]. The estimated von Bertalanffy growth constant are $L_t = 38.51[1 - e^{-0.328(t + 1.67)}]$ for females and $L_t = 34.12[1 - e^{-0.371(t + 1.07)}]$ for males in the Çamlıdere

Dam Lake. Many studies reported chub growth on the different area. It was reported that the constants $L_\infty = 31.8$ cm and $K = 0.28$ for Croatian [5]; $L_\infty = 24.5$ cm and $K = 0.206$ for Upor Stream (Czech Republic) [17].

The von Bertalanffy growth parameters of chub on Turkish populations were seen in Table 2. While the maximum L_∞ values for female and male were 74.0 cm in Sır Dam Lake [14] and 54.5 cm in Tödürge Lake [8]; the minimum L_∞ values for female and male 28.6 cm in Işıklı Lake [13] and 26.71 cm in İkizcetepeler Dam Lake [19]. As seen in Table 3, the mean condition factor values for the 6 European ecosystems (except Turkey) varies from 0.99 (in Lika River, Croatia, [7]) to 1.49 (in Upor Stream, Czech Republic, [17]). In Turkey, maximum and minimum condition factor reported as 2.40 and 0.77 in İkizcetepeler Dam Lake [19], respectively (Table 2). This variation may be due to different stages in ontogenetic development, as well as differences in condition, length, age, sex and gonadal development [25].

Table 3. Summary of the available studies on length-weight relationships (b) and Condition factors (CF) for *S. cephalus* inhabiting different areas. (TL: total length, SL: standart length) (* indicates not expressed data).

Country	Area	Length	n	b	CF	References
	Dobra River		87	3.369	1.08	
	Bednja River		108	2.872	1.29	
Croatia	Lika River	TL	24	2.670	0.99	[7]
	Kupa River		20	3.240	1.10	
	Lonja River		13	2.875	1.21	
Rep. of Macedonia	Vardar River	*	229	2.88	*	[10]
Greece	Strymon Estuary	TL	627	3.856	*	[11]
Czech Republic	Upor Stream	SL	379	3.066	1.49	[17]

4. References

1. Slastenenko E. (1956). Karadeniz Havzası Balıkları. Et ve Balık Kurumu Umum Müdürlüğü Yayınları, 711pp.
2. Geldiay R., Balık S. (1996). Türkiye Tatlısu Balıkları. Ege Üniversitesi Su Ürünleri Fakültesi Yayınları. No 46, İzmir, 532 s.
3. Gümüş A., Polat N. (1994). Tatlısu kefali (*Leuciscus cephalus* L., 1758)'nin beş kemiksi yapısında yaş tayini ve uyum değerlendirmesi. *Trakya Üniversitesi XII. Ulusal Biyoloji Kongresi*, 64-70.
4. Altındağ A. (1997). Reproduction and feeding of the chub (*Leuciscus cephalus*, L. 1758) in Akşehir Lake (Konya). *Turkish Journal of Zoology*, **21**, 229-240.
5. Treer T., Habekovic D., Anicic I., Safner R., Kolak A. (1997). Standard growth curve for chub

- (*Leuciscus cephalus* L.:1758) in Croatia. *Ribarstvo*, **55**, 47-52.
6. Yerli S.V., Çalışkan M., Canbolat A.F. (1999). Çıldır Gölü (Ardahan)'ndeki *Leuciscus cephalus*'un büyüme ölçütleri üzerine incelemeler. *Turkish Journal of Zoology*, **23**, 271-278.
 7. Treer T., Habekovic D., Safner R., Kolak A., Anicic I. (1999). Length-mass relationship in chub (*Leuciscus cephalus*) from five Croatian Rivers. *Agriculturae Conspectus Scientificus*, **64**, 137-142.
 8. Ünver B., Tanyolaç J. (1999). Growth Properties of Chub (*Leuciscus cephalus* L., 1758) in Lake Tödürge (Zara/Sivas). *Turkish Journal of Zoology*, **23**, (supplement 1), 257-270.
 9. Şaşı H., Balık S. (2003). Topçam Baraj Gölü'ndeki (Aydın) tatlısu kefalinin (*Leuciscus cephalus* L., 1758) yaş, büyüme ve cinsiyet oranları. *Ege Üniversitesi Su Ürünleri Dergisi*, **20**, 503-515.
 10. Georgiev S. (2003). Length-weight relationship of six Cyprinid fish in the River Vardar (Republic of Macedonia). *Ribarstvo*, **61**, 89-102.
 11. Koutrakis E.T., Tsikliras A.C. (2003). Length-weight relationships of fishes from three northern Aegean estuarine systems. *Journal of Applied Ichthyology*, **19**, 258-260.
 12. Markovic G., Simic V., Ostojic A., Simic S. (2003). The diet of *Leuciscus cephalus* L. in the reservoir Medjuvrje (Western Morava, Serbia). *Acta Agriculturae Serbica*, **8**, 75-81.
 13. Balık S., Sarı H.M., Ustaoglu M.R., İlhan A. (2004). Işıklı Gölü (Çivril, Denizli, Türkiye) (*Leuciscus cephalus* L., 1758) populasyonunun yaş ve büyüme özellikleri. *Ege Üniversitesi Su Ürünleri Dergisi*, **21**, 257-262.
 14. Kara C., Solak K. (2004). Sır Baraj Gölü (Kahramanmaraş)'nde yaşayan tatlısu kefal (*Leuciscus cephalus* L., 1758)'nin büyüme özellikleri. *KSÜ. Fen ve Mühendislik Dergisi*, **7**, 1-8.
 15. Kalkan E., Yılmaz M., Erdemli A.Ü. (2005). Some biological properties of the *Leuciscus cephalus* (L., 1758) population living in Karakaya Dam Lake in Malatya (Turkey). *Turkish Journal of Veterinary and Animal Science*, **29**: 49-58.
 16. Piria M., Treer T., Anicic I., Safner R., Odak T. (2005). The natural diet of five Cyprinid fish species. *Agriculturae Conspectus Scientificus*, **70**, 21-28.
 17. Vlach P., Dusek J., Svatora M., Moravec P. (2005). Growth analysis of chub, *Leuciscus cephalus* (L.), and dace, *Leuciscus leuciscus* (L.), in the Upor stream using growth data of recaptured marked fish. *Czech Journal of Animal Science*, **50**, 329-339.
 18. Karataş M., Can M.F. (2005). Growth, mortality and yield of chub (*Leuciscus cephalus* L., 1758) population in Almus Dam Lake. Turkey. *Journal of Biological Sciences*, **5**, 729-733.
 19. Koç H.T., Erdoğan Z., Tinkci M., Treer T. (2007). Age, growth and reproductive characteristics of chub, *Leuciscus cephalus* (L., 1758) in the İkizcetepeler Dam Lake (Balıkesir), Turkey. *Journal of Applied Ichthyology*, **23**, 19-24.
 20. Yılmaz S., Yılmaz M., Polat N. (2007). Divanbaşı Göleti (Kavak, Samsun)'nde yaşayan tatlı su kefalinin (*Leuciscus cephalus* L., 1758) altı kemiksi yapısından yaş tayini. *İstanbul Üniversitesi, Su Ürünleri Dergisi*, **23**, 67-80.
 21. Özden S., Kavruk F. M. (2005). Türkiye'deki barajlar ve hidroelektrik santraller. DSİ İdari ve Mali İşler Dairesi Başkanlığı Basım ve Foto-Film Şube Müdürlüğü, 41 s.
 22. Baykal T. (1998). Çamlıdere Baraj Gölü kıyı bölgesi alglerinin mevsimsel değişimi. Doktora Tezi, Gazi Üniversitesi, Fen Bilimleri Enstitüsü, Ankara, 118s.
 23. Chugunova N.I. (1963). Age and Growth Studies in Fish. National Science Foundation, Washington, 132 pp.
 24. Campana S.E. (2001). Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. *Journal of Fish Biology*, **59**: 197-242.
 25. Ricker W.E. (1975). Computation and interpretation of Biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada 191, 382 pp.
 26. Bostancı D. (2005). Bafra Balık Gölü ve Eğirdir Gölü'nde yaşayan balık populasyonlarında opak birikim analizi ile yaş doğrulaması. Doktora Tezi, Ondokuz Mayıs Üniversitesi Fen Bilimleri Enstitüsü, Samsun, 136s.
 27. Türkmen M., Haliloğlu H.İ., Erdoğan O., Yıldırım A. (1999). The growth and reproduction characteristics of chub *Leuciscus cephalus orientalis* (Nordmann, 1840) living in the River Aras. *Turkish Journal of Zoology*, **23**, 355-364.
 28. Erdoğan O., Türkmen M., Yıldırım A. (2002). Studies on the age, growth and reproduction characteristics of the chub, *Leuciscus cephalus orientalis* (Nordmann, 1840) in Karasu River, Turkey. *Turkish Journal of Veterinary and Animal Science*, **26**, 983-991.
 29. Hamwi N., Raikowa-Petrova G., I.K. (2005). Age and size composition of chub (*Leuciscus cephalus* L.) in the middle stream of the Iskar River, Bulgaria. *Acta Zoologica Bulgarica*, **57**, 363-370.
 30. Froese R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, **22**, 241-25.