Turk J Vet Anim Sci
29 (2005) 665-676

Research Article

Age, Growth and Condition of *Capoeta capoeta angorae* Hanko 1924 from the Upper Water Systems of the River Ceyhan, Turkey

Ahmet ALP
Department of Fisheries, Faculty of Agriculture, Kahramanmaraş Sütçü İmam University, Kahramanmaraş - TURKEY
E-mail: aalp@ksu.edu.tr

Cemil KARA
Department of Biology, Faculty of Science and Arts, Kahramanmaraş Sütçü İmam University, Kahramanmaraş - TURKEY

H. Murat BÜYÜKÇAPAR
Department of Fisheries, Faculty of Agriculture, Kahramanmaraş Sütçü İmam University, Kahramanmaraş - TURKEY

Orhan BÜLBÜL
Kahramanmaraş Directorate of Agricultural and Rural Affairs, Kahramanmaraş - TURKEY

Received: 05.06.2003

Abstract: The age, growth and condition factors were described for *Capoeta capoeta angorae* from the upper parts of the River Ceyhan from May 2000 to February 2001 and the differences in length in the same age group between streams and reservoirs populations were compared. A total of 629 *C. c. angorae* were examined and the ratio of males to females was estimated as 1.25:1.00. Eleven age groups were recorded from 0+ to 10+ years old and two- and three-year-old fish dominated the sample.

The fork lengths (FLs) ranged from 3.1 to 41.5 cm and the majority of the samples were composed of 14.0 and 16.0 cm FL groups. The length-weight relationships were described as $W = 0.0242 \times FL^{2.8067}$ ($r = 0.9776$) for males and $W = 0.0348 \times FL^{2.6811}$ ($r = 0.9841$) for females. Growth was expressed in length and the von Bertalanffy growth parameters were estimated as $L\infty = 47.3$ cm, $K = 0.133$, $t_0 = -0.761$ for males and $L\infty = 62.3$ cm, $K = 0.101$, $t_0 = -0.598$ for females. Growth performance index were also estimated as $\varphi' = 5.693$ for males and $\varphi' = 5.970$ for females. The differences in length in the same age groups between stream and reservoir populations were statistically significant ($P < 0.05$) and the FLs of reservoir populations were higher than those of the streams.

The condition factors ranged from 0.687 to 2.615 with a mean value of 1.413 and the differences in condition between males and females were significant in the first and second age groups, while they were not significant at the other ages.

Key Words: *Capoeta capoeta angorae*, river Ceyhan, age, growth, condition factor

Yukarı Ceyhan Nehir Sistemindeki *Capoeta capoeta angorae* Hanko, 1924'nın Yaş, Büyüme ve Kondüsyon Faktörleri

Özet: Yukarı Ceyhan Havzası'ndaki *Capoeta capoeta angorae*'nın yaş, büyüme ve kondüsyon faktörleri Mayıs 2000 ve Şubat 2001 tarihleri arasında incelenerek, dere ve baraj populasyonlarındaki aynı yaş gruplarına ait boylar karşılaştırılmıştır. İncelenen toplam 629 *C. c. angorae* bireyinde erkek:dişi oranı 1,25:1,00 olarak hesaplanmıştır. 0+-10+ arası toplam 11 yaş grubu belirlenmiş, 2+ ve 3+ yaş grupları çoğunluğu oluşturmuştur.

Çatal boylar 3,1 ile 41,5 cm arasında değişmiş ve çoğunluğun 14,0 ve 16,0 cm boy grubuna dahil olduğu görülmüştür. Boy ağırlık ilişkileri erkekler için; $W = 0,0242 \times FL^{2,8067}$ ($r = 0,9776$) ve dişiler için ise; $W = 0,0348 \times FL^{2,6811}$ ($r = 0,9841$) olarak bulunmuştur. Büyüme boy uzunluğu ile ifade edilmiş ve von Bertalanffy parametreleri erkekler için; $L\infty = 47,3$ cm, $K = 0,133$, $t_0 = -0,761$ ve dişiler içinse; $L\infty = 62,3$ cm, $K = 0,101$, $t_0 = -0,598$; büyüme performansı indeksleri erkeklerde $\varphi' = 5,693$, dişilerde ise $\varphi' = 5,970$ şeklinde bulunmuştur. Baraj göllerinde yaşayan *C. c. angorae*'ların akarsulara göre daha büyük olduğu tesbit edilmiştir ($P < 0,05$)

Kondüsyon faktörleri 0,687 ile 2,615 arasında değişmiş ve ortalama 1,413 olarak bulunmuştur. Aynı yaş gruplarındaki dişi ve erkek arasındaki kondüsyon farkı ilk yaşlarda istatistiki açıdan önemli bulunurken ileriki yaşlarda önemsiz bulunmuştur.

Anahtar Sözcükler: *Capoeta capoeta angorae*, Ceyhan nehri, yaş, büyüme, kondüsyon faktörü

Introduction

The River Ceyhan is an important aquatic system in Turkey and its main catchment area is located in the province of Kahramanmaraş. Although during the last two decades the catchment area of this river system has undergone great changes in its morphology, ecology and limnology, fish populations in the region have not been investigated well enough.

This paper focuses on *Capoeta capoeta angorae*, which is widely distributed in the River Ceyhan system. This subspecies inhabits the majority of the zone in the Ceyhan River and it is important for commercial fishing in the reservoirs of Menzelet, Sır and Aslantaş, and is caught by long line gill nets. It is also important for recreational fishing in the streams of Tekir and Fırnız. The annual total catch in the Menzelet Reservoir in the study area varied from 26,000 to 34,703 kg and 4746-6797 kg of this was represented by *C.c. angorae*, *Capoeta barroisi* and *Barbus rajanorum* (1).

Capoeta is distributed in southern China, northern India, Turkmenistan, Lake Aral, the Middle East and Anatolia (2). The individuals of this genus occurs in lenitic systems as well as lotic systems, and it was reported in Sarıyer (3,4), Aslantaş – Mehmetli (5), Almus (6) and Kalecik (7) reservoirs and in Hazar (8), Nazik (9) and Çıldır (10) lakes in Turkey. According to Geldiay and Balık (11), there are five species (*C. capoeta, C. trutta, C. barroisi, C. pestai* and *C. tinca*) and six subspecies (*C.c. capoeta, C.c. angorae, C.c. bergamae, C.c. kosswigi, C.c. sieboldi* and *C.c. umbla*) of this genus in the inland waters of Turkey.

In Geldiay and Balık (11), *C.c. angorae* were reported as *Varicorhinus capoeta angorae* in Pozantı (Adana); *Varicorhinus damascinus* in Pozantı and Karasu; *Varicorhinus damascinus* in Pozantı and Antalya; *Capoeta capoeta angorae* in Pozantı, Aksu (Maraş), River Ceyhan, Antalya and Samantı Stream; *Varicorhinus damascinus* in Ova Stream; *Varicorhinus fratercula* in southern Anatolia; *Capoeta capoeta angorae* in the streams of Dragon (Anamur), Lamas (Erdemli), Dim (Alanya), Kargı (Alanya), Çakıt (Pozantı), Berdan (Tarsus), Fennele (Aksu Antalya), Alara (Manavgat), Karpuz (Alanya), Eğlence (Adana) and River Asi. *C. c. angorae* was also reported by Balık (12) from the River Ceyhan, River Seyhan and in the streams of southern Turkey.

The biological characteristics such as growth, reproduction and taxonomy of *Capoeta capoeta umbla* (2,7,8,13), *Capoeta tinca* (3,6,14-17), *Capoeta trutta* (7,18-20), *Capoeta capoeta capoeta* (8,9,21) and *Capoeta barroisi* (5) were investigated; however, we have not enough information about *C. c. angorae* in Turkey. Therefore, the aim of this study was to investigate its age, growth, condition factors and the differences in fish size between streams and reservoirs populations. In addition, the effects of the dams constructed in the Ceyhan River Basin on the some biological characteristics such as growth and condition of *C.c. angorae* were determined.

Materials and Methods

The present study was conducted on the upper parts (Fırnız Stream, Tekir Stream, and Suçatı and Menzelet Reservoirs) of the River Ceyhan from May 2000 to February 2001. In recent years, the River Ceyhan system has undergone great changes and high dams such as Aslantaş, Berke, Sır, Kılavuzlu, Menzelet and Suçatı have been constructed, successively, and other dam projects are planned on the river system (Figure 1).

Menzelet Reservoir has five major tributaries, Fırnız Stream, Tekir Stream, Zeytin Stream, Bertiz Stream and the River Ceyhan. Fırnız and Tekir streams join together in the Suçatı region and form Güredin Stream. However, the Suçatı Dam was constructed on Güredin Stream in 1999 and fish migrations were stopped from Menzelet Reservoir to Fırnız and Tekir streams and from these streams to the Menzelet Reservoir (Figure 1). The other two streams, Zeytin and Bertiz, are generally dry in the summer months.

Fırnız Stream is located at a latitude of 37° 45' N, longitude of 36° 39' E and altitude of 730 m. The catchment area of Fırnız Stream is about 178.5 km^2 and its flows vary from 1500 to 5500 l/s. It is about 12 km long. The water temperature of Stream Fırnız varied from 8.2 to 11.4 °C and pH and electrical conductivity was 8.65 and 250-525 mmhos/cm (22). Fish fauna of Fırnız Stream was represented by *Salmo trutta macrostigma*, *Capoeta capoeta angorae*, *Phoxinellus* sp., *Garra rufa*, *Nemacheilus angorae*, *Nemacheilus* sp. and *Blennius fluviatilis*. The dominant fish species in the fauna was *Salmo trutta macrostigma* at the upper region and *Capoeta capoeta angorae* at the lower region (22,23).

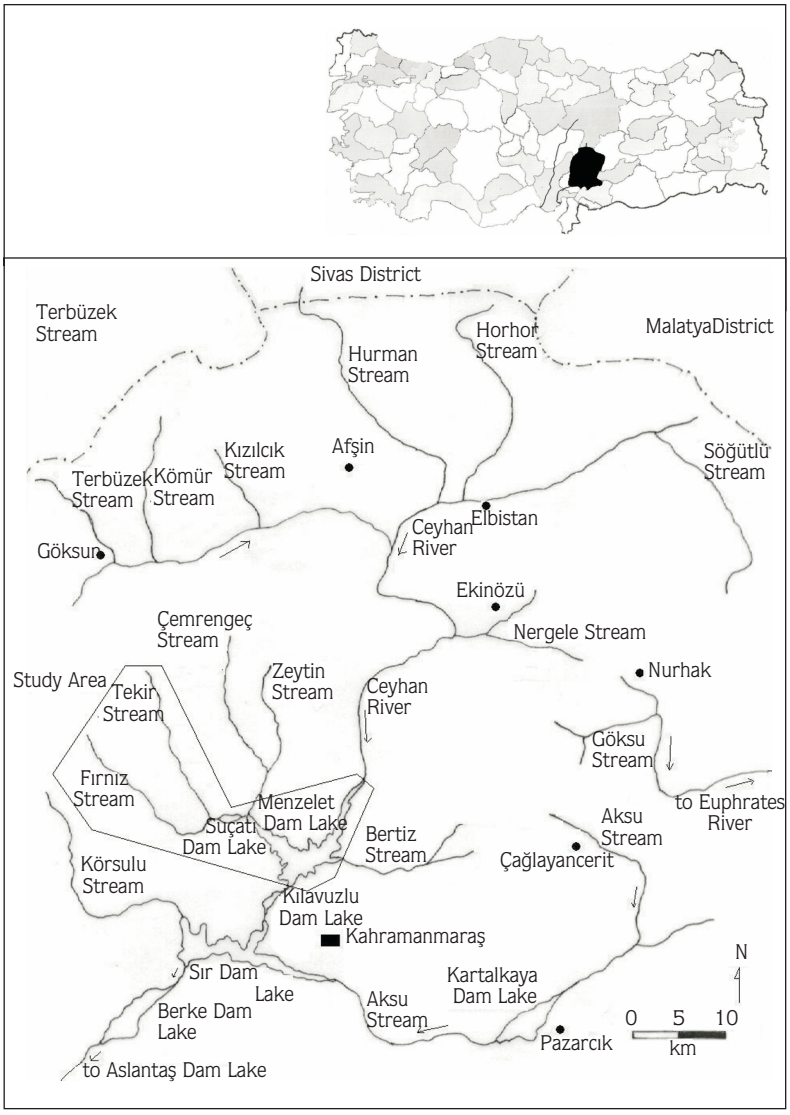

Figure 1. The map of the River Ceyhan and study area.

Tekir Stream is located near Fırnız Stream at an altitude of 730-1200 m, and its catchment area is about 207.5 km^2 and its flows vary from 2500 to 5200 l/s. Tekir Stream disappears near the Kısık Village and appears again in Döngel Caves. However, the natural structure around this region has been destroyed by a newly constructed hydroelectric power station (Döngel Hydroelectric Power Station), and so the flowing regime of this stream has become changeable even daily. Tekir Stream is about 27 km long. Its water temperature varied from 7.2 to 10.5 °C and pH and electrical conductivity were 8.14 and 340-620 mmhos/cm (22). Fish fauna of Tekir Stream was represented by *Capoeta capoeta angorae*, *Phoxinellus* sp., *Garra rufa*, *Nemacheilus angorae*, *Nemacheilus* sp. and *Blennius fluviatilis*. The majority of the fish fauna was represented by *Capoeta capoeta angorae* but *Blennius fluviatilis* dominates in some of the area, locally (22,23).

Menzelet Reservoir has a surface area 42 km^2 at 700 m in altitude and it is used for electrical energy production. The maximum depth is nearly 100 m and total water deposits are about 12 x 10^9 m^3. Fish fauna of the reservoir consisted of *Silurus glanis, Cyprinus carpio, Capoeta capoeta angorae, Capoeta barroisi, Barbus rajanorum*, and *Alburnus orontis*. *C. carpio* has been introduced to the reservoir after the construction of the

dam lake but others are original species of the River Ceyhan. *Anguilla anguilla* used to inhabit this area but now it is extinct, because of dam lake constructed on the river systems and the lack of fish passages. Thirty fishermen fish the Menzelet Reservoir and annual total catch varies from 25 to 35 t, of which 15 t consists of *S. glanis*, 15 t consists of *C. carpio* and 5 t consists of *C. c. angorae, C. barroisi and B. rajanorum* (1,24). *C. c. angorae, C. barroisi and B. rajanorum* migrate to the flowing waters especially to the lower streams. Water temperature of the Menzelet Reservoir varied from 6.9 to 30.4 °C, thermal stratification occurs in summer and surface water is never covered by ice in winter. pH and electrical conductivity were 8.14-8.86 and 304-441 mmhos/cm, respectively (25).

Suçatı Reservoir is between streams (Tekir and Fırnız) and the Menzelet Reservoir. Therefore, its water quality varied between streams water quality and Menzelet Reservoir water quality. This dam lake has no fish passages and so fish migration is affected negatively.

Of the 629 *C. c. angorae* examined in this study, 255 were obtained from Fırnız Stream, 289 from Tekir Stream and 85 from the Menzelet and Suçatı reservoirs. The samples obtained from the streams were caught using an electroshocker, while the samples from the reservoirs were caught using long line gill nets with 30 and 40 mm mesh size.

Fresh samples of *C. c. angorae* were taken to the laboratory into 4% formalin solution and total weight (W), fork length (FL) and sex of each fish were recorded. The scales of each sample were prepared for age determinations and age readings were performed according to Chugunova (26).

The ratio of males to females was tested with X^2- test (27). Length-weight relations were calculated by applying regression analysis by taking ln of fork length (x) to total weights (y) of each fish (28) and the equations were as follows:

$$\ln W = a + b \times \ln FL$$

$$q = \exp^a$$

$$W = q \times FL^b$$

where W is the total weight, FL the fork length, and "a" and "b" are the parameters to be estimated (28). The exponents (b) for females and males were presented with their 95% confidence intervals.

Growth parameters, $L\infty$, K and t_0, were found using the FISAT software package (29) and the von Bertalanffy growth equations for males and females were as follows:

$$L(t) = L\infty \times [\, 1 - \exp^{(-k \times (t - t0))} \,]$$

where "$L\infty$" is the average asymptotic fork length, "k" the growth coefficient, which determines how fast the fish approaches $L\infty$, and t_0 the hypothetical age for $L_{(t)} = 0$ cm.

Growth performance index (phi-prime index) φ' was computed from the equation: $\varphi' = \ln k + 2 \times \ln L\infty$ (30). The differences in length, weight and condition between males and females and between reservoir and stream populations were tested with the Tukey HSD or "t" test (27).

The condition factor of *C. c. angorae* were estimated by $C=(W/FL^3)x100$ by using body weights (g) and FL (cm) (28).

Results

Length, weight frequencies and age distribution

Of the examined fish samples, 259 were females, 312 males and 58 immatures. The ratio of males to females was estimated as 1.25:1.00 and this was not statistically significant ($P > 0.05$). There was no immature individuals in the samples obtained from the reservoir populations.

Eleven age groups were recorded from 0+ to 10+ for *C. c. angorae* (Figure 2a). In both sexes, two and three-year-old fish dominated the sample, accounting for over 50% of the total. Older fish were poorly represented. All of the eight, nine and ten year-old fish were female and the oldest recorded female was ten years old, while the oldest male was seven years old.

C. c. angorae ranged from 3.1 to 41.5 cm (Figure 2b) and the majority of the samples were composed of 14.0 and 16.0 cm length groups. The differences in length between streams and reservoirs samples were statistically significant ($P < 0.05$) and the fish obtained from the Menzelet and Suçatı Reservoirs were bigger than those of the streams. This probably resulted from the selectivity of the gill nets (30 and 40 mm mesh size) used in the reservoirs. Therefore, it was not possible to catch small individuals from the reservoirs.

The length-weight relationships of the *C. c. angorae* were estimated using 312 males and 259 females. The exponents (b) with ± 95% CI for males and females were

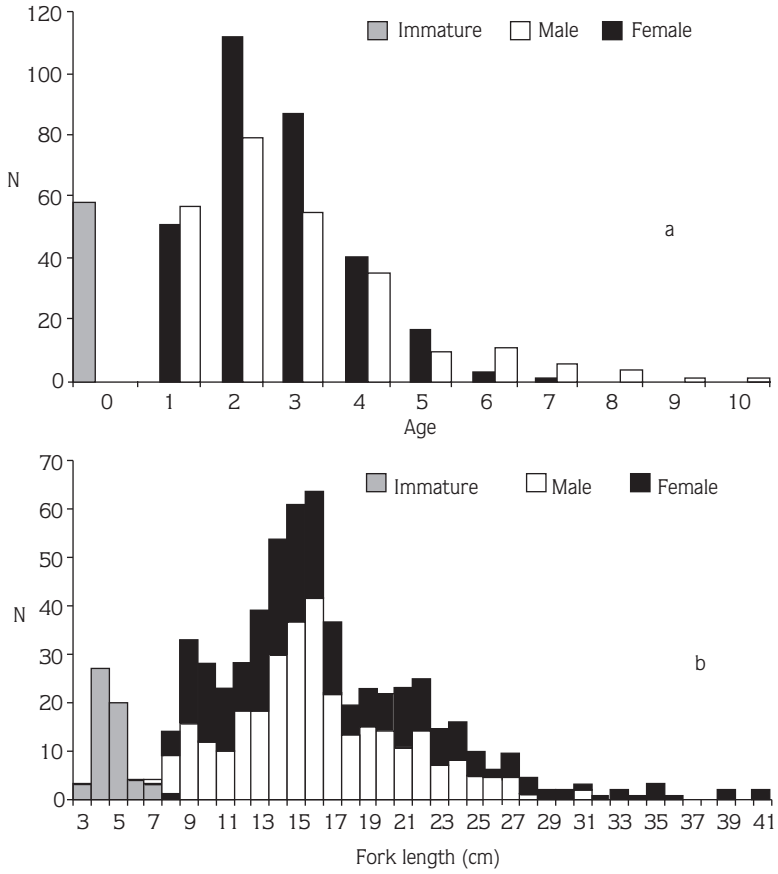

Figure 2. Age and length distributions of *C.c. angorae* from the upper part of the River Ceyhan. a) Age frequency distribution, b) Length distribution.

estimated as b = 2.8067 ± 0.068 and b = 2.6811 ± 0.060, respectively. These relationships were found as $W = 0.0242xFL^{2.8067}$ for males and $W=0.0348*FL^{2.6811}$ for females (Figure 3).

The growth characteristics and condition factors

The fork lengths in the age groups of female, male and immature *C. c. angorae* were given in Table 1. The differences in mean length between females and males in the same age groups were not statistically significant ($P > 0.05$).

The growth parameters estimated from FISAT were $L\infty = 62.3$ cm, $K = 0.101$, $t_0 = -0.598$ for females and $L\infty = 47.3$ cm, $K = 0.133$, $t_0 = -0.761$ for males. Von Bertalanffy growth model of the *C. c. angorae* population in the River Ceyhan was described as $L_{(t)} = 62.3 \times [1 - e^{(-0.101 \times (t + 0.598)}]$ for females and $L_{(t)} = 47.3 \times [1 - e^{(-0.133 \times (t + 0.761)}]$ for males. Growth curves using von Bertalanffy equations were formed for males and females as in Figure 4. The total weights in the age groups of *C. c. angorae* are presented in Table 1.

The fork length of the samples obtained from the streams and reservoirs and the differences in length at the same age groups are presented in Table 2. The fork lengths of the same age groups of *C. c. angorae* obtained from Menzelet and Suçatı reservoirs were greater than those of the stream populations and the differences were statistically significant (Tekir^{b}, Fırnız^{b} and Menzelet^{a} for age 3+; Tekir^{c}, Fırnız^{b} and Menzelet^{a} for age 4+ and Tekir^{b}, Fırnız^{b} and Menzelet^{a} for age 5+ in Tukey HSD test and $P < 0.05$ for age 6 in t-test) (Table 2).

From the length-weight relationships and the estimated L∞, the asymptotic weight (W∞) was calculated as 2281.31 g and 1197.05 g, respectively, for females and males.

The condition factors of 629 *C. c. angorae* were investigated for age groups and ranged from 0.687 to

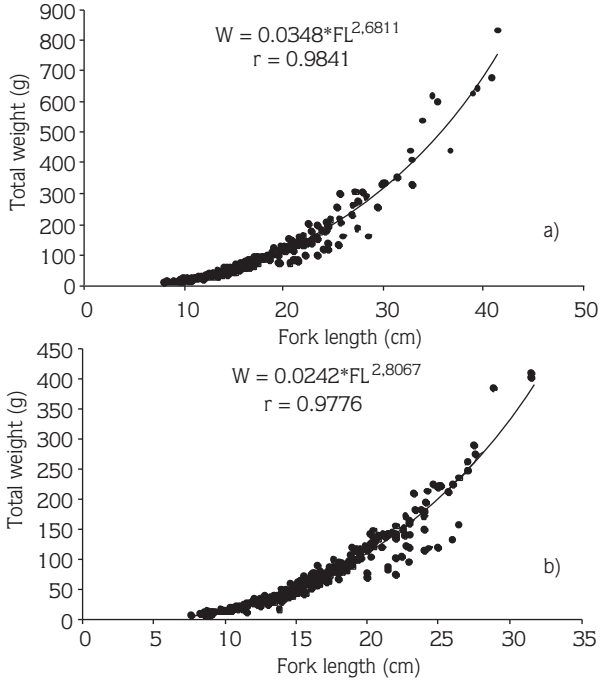

Figure 3. Length-weight relationships in *C.c. angorae* from the upper parts of the River Ceyhan. a) for females, b) for males.

2.615 with a mean value of 1.413. The differences in condition factors between males and females were significant in the first and second age groups ($P < 0.05$), while they were not significant ($P > 0.05$) in the other age groups (Table 3). The condition factors, mean lengths and mean weights in the habitats are given in Table 4 according to the seasons. The differences among the habitats in the condition factors of the months were significant (Tekir[b], Fırnız[b] and Menzelet[a] in January; Tekir[c], Fırnız[b] and Menzelet[a] in September and October in Tukey HSD test and $P < 0.05$ in November in t-test).

Discussion

In the present study of 629 *C. c. angorae*, 312 were male and 259 female and the ratio of males to females (M:F) was 1.25:1.00. This ratio did not differ from the ratio of 1.00:1.00. Overall sex ratio of the *C. capoeata* populations in Turkey is presented in Table 5. The overall sex ratios reported by Ekmekçi (4), Erdoğan (21), Şen et al. (9) and Türkmen et al. (2) were similar to the present

Table 1. The fork lengths (cm) and total weights (g) in the age groups of *Capoeta capoeta angorae* from the upper parts of the River Ceyhan. (I: Immature; M: Male; F: Female).

Age group	Sex	N	FL (cm)	Range	SE	W (g)	Range	SE
0+	I	58	5.0	3.1-8.0	0.135	1.6	0.23-6.32	0.148
1+	M	51	10.3	7.7-16.2	0.233	17.4	7.7-67.4	1.524
	F	57	10.6	8.0-13.6	0.179	20.1	9.1-43.6	1.126
2+	M	112	14.9	10.9-20.8	0.175	50.8	17.7-138.7	1.921
	F	79	14.7	10.0-18.6	0.182	48.7	19.4-91.3	1.665
3+	M	87	17.3	12.8-21.7	0.205	81.5	38.8-144.2	2.708
	F	55	17.9	13.6-22.0	0.285	90.2	40.3-157.7	3.985
4+	M	41	22.2	18.0-26.0	0.278	132.3	68.0-223.6	5.874
	F	35	22.7	19.5-28.5	0.323	137.2	73.0-296.9	7.721
5+	M	17	25.0	22.0-31.5	0.563	201.6	104.0-409.0	17.353
	F	10	25.6	24.4-29.5	0.506	206.3	135.0-254.8	1.069
6+	M	3	27.8	27.0-28.8	0.537	311.3	261.0-383.0	36.806
	F	11	28.6	27.0-31.4	0.467	292.9	184.0-353.8	4.025
7+	M	1	31.5			401.0		
	F	6	34.8	33.0-36.8	0.621	491.5	328.0-618.0	0.674
8+	F	4	36.7	32.8-41.0	1.965	568.0	436-0-676.0	1.085
9+	F	1	39.5			643.0		
10+	F	1	41.5			832.0		

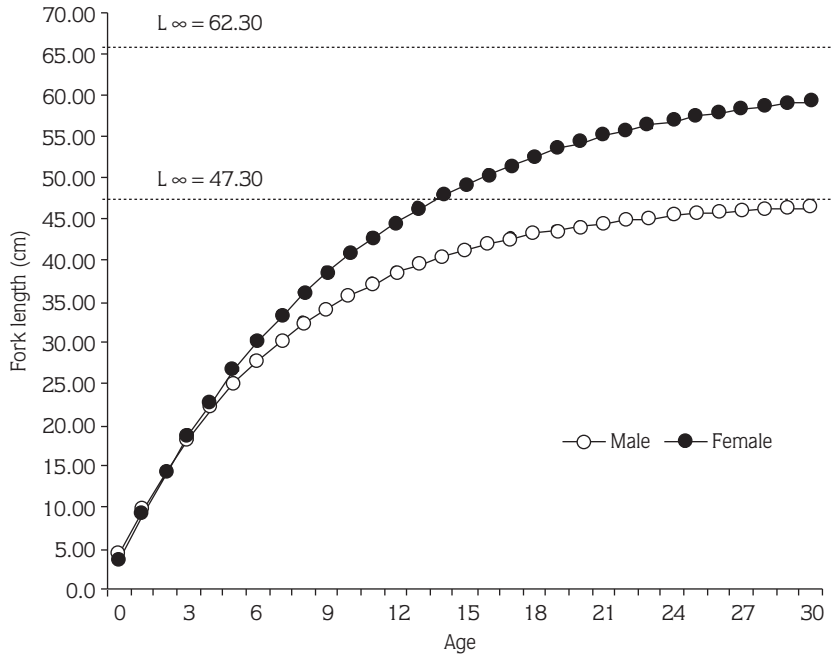

Figure 4. Von Bertalanffy growth curves for both sexes of *C.c. angorae* from the upper parts of the River Ceyhan.

Table 2. The fork lengths (cm) and body weights of *Capoeta capoeta angorae* obtained from the streams and reservoirs and their comparisons. (The same letter such as [a,b and c] on the mean values indicate that the differences are not significant in Tukey HSD test and * indicates that the differences between two habitats are significant in t-test).

Age	Locality	N	Mean FL (cm)	SE	Mean W (g)	SE
0+	Tekir Stream	53	4.9	0.125	1.58	0.96
	Fırnız Stream	5	5.5	0.840	1.81	0.432
1+	Tekir Stream	53	10.7	0.217	20.33	1.174
	Fırnız Stream	55	10.2	0.210	17.38	1.084
2+	Tekir Stream	101	14.8	0.138	48.95	1.370
	Fırnız Stream	90	15.1	0.185	51.033	1.512
3+	Tekir Stream	65	16.5[b]	0.175	77.84[b]	2.919
	Fırnız Stream	61	17.7[b]	0.230	82.26[b]	3.968
	Menzelet and Suçatı R.	16	21.3[a]	0.406	118.94[a]	5.697
4+	Tekir Stream	11	20.1[b]	0.597	113.60[b]	4.854
	Fırnız Stream	25	21.5[b]	0.313	116.78[b]	6.558
	Menzelet and Suçatı R.	40	23.8[a]	0.235	151.82[a]	7.007
5+	Tekir Stream	6	24.0[b]	0.491	178.60[b]	11.390
	Fırnız Stream	11	24.3[b]	0.438	188.84[b]	9.006
	Menzelet and Suçatı R.	10	27.1[a]	0.288	234.53[a]	18.592
6+	Fırnız Stream	8	26.5*	0.512	245.8*	5.570
	Menzelet and Suçatı R.	6	31.0*	0.974	362.7*	12.410
7+	Menzelet and Suçatı R.	7	34.3	0.637	478.6	1.672
8+	Menzelet and Suçatı R.	4	36.7	1.965	568	1.085
9+	Menzelet and Suçatı R.	1	39.5		643	
10+	Menzelet and Suçatı R.	1	41.5		832	

Table 3. The condition factors in the age groups of *Capoeta capoeta angorae* from the upper parts of the River Ceyhan. (I: Immature; M: Male; F: Female).

Age	Sex		N	Mean condition factor	Range	SE	Sign. P value
0+	I	:	58	1.118	0.692 - 1.448	0.023	
1+	M	:	51	1.485	0.702 - 2.207	0.039	P < 0.05
	F	:	57	1.606	1.050 - 2.597	0.031	
2+	M	:	112	1.477	1.088 - 1.865	0.014	P < 0.05
	F	:	79	1.514	1.097 - 2.473	0.025	
3+	M	:	87	1.543	1.207 - 2.615	0.030	P > 0.05
	F	:	55	1.529	0.958 - 1.987	0.027	
4+	M	:	41	1.209	0.704 - 1.730	0.045	P > 0.05
	F	:	35	1.167	0.687 - 1.749	0.051	
5+	M	:	17	1.260	0.844 - 1.418	0.037	P > 0.05
	F	:	10	1.233	0.918 - 1.558	0.060	
6+	M	:	3	1.441	1.326 - 1.603	0.084	P > 0.05
	F	:	11	1.256	0.894 - 1.527	0.047	
7+	M	:	1	1.283			
	F	:	6	1.159	0.879 - 1.441	0.093	
8+	F	:	4	1.158	0.981 - 1.366	0.088	
9+	F	:	1	1.043			
10+	F	:	1	1.164			
Total		:	629	1.413	0.687 - 2.615	0.011	

result. Türkmen et al. (2) reported that the sex ratio of *C. c. umbla* showed a regular change during the spawning migration, males usually predominating at the start, after which the ratio became nearly 1.00:1.00, followed by a predominance of females. In accordance with the above statements, in the present study, the predominance of males in the sample may have resulted from the majority of the samples being obtained in the spawning season (May-June).

The males were predominant at the age of 2+, 3+, 4+, 5+ and 6+, while the females were dominant after the 6+ age. Similar situations were reported for *C. c. umbla* (2,8), and *C. c. capoeta* (10). Türkmen et al. (2) reported that these were due to earlier maturing and males living not as long as females.

In the present study, the exponent (b) in the length-weight relationships for males and females (b= 2.6811 for males and b= 2.8067 for females) indicated that weight growth of *C. c. angorae* was isometric. The exponent (b) values of the *Capoeta capoeta* populations are given in Table 5, with a comparison to "b" values estimated in the present study. The exponents "b" in this table ranged from 2.54 (31) to 3.23 (7) and our results are within this range. The variations in the exponents "b" may have resulted from the different stages in the ontogenetic development, and differences in age, maturity, sex and species (2).

The maximum observed size (FL=41.5 cm) in the present study is relatively greater than that of *C. c. sieboldi* (4,32) and *C. c. umbla* (13,33), but it was similar to *Capoeta capoeta capoeta* (9) and *Capoeta capoeta umbla* (2,31). Females were longer and heavier than males, especially at older ages. This was similar to the results reported by Türkmen et al. (2), and Erdoğan (21). In the present study L_∞ of the females was found to be higher than that of the males, and this may be due to faster growth of females. However, the males attained to the L_∞ earlier than females. Growth performance index (or phi-prime index, φ') of the females was also higher than that of the males. L_∞, K, b

Table 4. The condition factors, the mean lengths (FL) and weights (g) of *Capoeta capoeta angorae* in the habitats with the seasons. (The same letter such as [a,b and c] on the mean values indicate that the differences are not significant in Tukey HSD test and * indicates that the differences between two habitats are significant in t-test).

Month	Locality	N	Mean Condition	Range	SE	Mean FL (cm)	Mean W (g)
January	Tekir Stream	46	1.579b	1.331-2.006	2.006	14.02	48.99
	Fırnız Stream	31	1.550b	1.268-1.987	1.987	16.12	78.60
	Menzelet and Suçatı R.	22	1.301a	1.035-1.551	1.551	25.55	238.96
February	Tekir Stream	30	1.748	1.289-1.826	0.027	15.13	69.58
	Fırnız Stream	17	1.614	1.389-1.908	0.029	14.03	59.67
March	Menzelet and Suçatı R.	25	0.887	0.786-1.05	0.014	24.69	163.92
April	Menzelet and Suçatı R.	5	1.397	1.309-1.503	0.035	29.80	400.60
June	Tekir Stream	55	1.166	0.692-2.615	0.037	5.08	2.73
	Fırnız Stream	53	1.247	0.958-1.526	0.017	13.58	36.76
	Menzelet and Suçatı R.	1	1.043			39.05	643.00
July	Tekir Stream	40	1.562	1.278-1.865	0.025	13.69	51.10
	Fırnız Stream	30	1.502	0.687-2.596	0.076	12.23	35.10
September	Tekir Stream	50	1.583c	1.303-2.008	0.022	15.32	60.17
	Fırnız Stream	52	1.347b	1.184-1.524	0.014	16.82	73.54
	Menzelet and Suçatı R.	22	1.269a	1.135-1.419	0.016	26.11	242.86
October	Tekir Stream	30	1.565c	1.226-1.872	0.027	14.71	50.97
	Fırnız Stream	36	1.428b	1.170-1.765	0.020	19.07	107.63
	Menzelet and Suçatı R.	10	0.785a	0.689-0.913	0.024	25.65	140.70
November	Tekir Stream	38	1.590*	1.364-2.055	0.023	14.42	52.83
	Fırnız Stream	36	1.406*	1.021-1.719	0.023	20.81	139.46

and φ' values of *Capoeta capoeta* populations in Turkey are given in Table 5. As shown in this table, although growth parameters, L∞ and K values, were different, growth performance index (φ') of the *Capoeta capoeta* populations ranged from 5.428 to 6.093 and they were relatively similar to each other. However, phi-prime index (φ') of the reservoir populations was found to be higher than that of the streams. Fish populations inhabiting standing waters have better growth performance than that of the flowing waters because of homogeny of ecological situations such as food abundance and water temperatures (10,16). In accordance with the above statements, the fork length of *C. c. angorae* from Menzelet and Suçatı reservoirs differed from the streams at the same age groups (Table 2). This is probably related to the water temperature of the habitats because the water temperature of the reservoirs is higher than that of the streams.

Table 5. Some parameters in age, growth, length-weight relationships and condition factor of the different Capoeta species from different regions in Turkey.

Author	Study area	Species	Sex	Sex ratio	Age	b	L∞ (cm)	K (year^{-1})	t_0	φ'	t_{max}	C
Türkmen et al. (2)	River Karasu	*C. c. umbla*	M	1.31/1	1-10	2.94	42.3	0.146	-0.98	5.565	20.6	
			F		1-12	2.99	45.7	0.139	-0.83	5.671	21.6	
Şen (7)	Kalecik Lake	*C.c. umbla*	M+F	0.29/1	1-7	3.23						
		C. turtta	M+F	1.51/1	1-8	2.99						
Korkmaz and Atay (13)	Şuğul Stream	*C.c. umbla*	M		0-5	3.032	42.55	0.166	-0.562	5.706	18.1	
			F		0-5	2.996	44.33	0.163	-0.536	5.769	18.4	
Girgin et al. (31)	Karakaya Dam	*C.c. umbla*	M	0.82/1	2-5	2.85						
			F		1-7	2.54						
Şen et al. (9)	Lake Nazik	*C. capoeta*	F+M	1.3/1	0-11	2.96	69.75	0.091	-0.357	6.093	32.9	
Canbolat et al. (10)	Çıldır Lake	*C.c. capoeta*	F+M	0.6/1	1-9							
Erdoğan (21)	River Aras	*C. c. capoeta*	M	1.16/1	1-11	2.98	44.3	0.116	-1.21	5.428	25.9	
			F		1-11	2.83	48.4	0.111	-0.79	5.561	27.0	
			M+F		1-11	2.86	47.5	0.112	-1.02	5.532	26.8	
Ekmekçi (4)	Sarıyer Dam	*C. c. sieboldi*	M	1.21/1	1-7							
			F		2-8							
Present study	River Ceyhan	*C. c. angorae*	M	1.25/1	1-7	2.8067	47.25	0.133	-0.761	5.693	22.6	1.437
			F		1-10	2.6811	62.25	0.101	-0.598	5.970	29.7	1.451

In the present study, condition factors ranged from 0.687 to 2.615, with a mean value of 1.413. The differences in condition between females and males were statistically significant at the age of 1 and 2; however, they were not significant in the other age groups. Condition factors that were high at the age of 1+ and 2+ decreased at the older ages. This situation is similar to the conditions of *C. trutta* reported by Gül et al. (20). The condition factors of *Capoeta capoeta* are not shown in Table 4, but the condition factors of *C. c. angorae* in the present study were higher than those of the Capoeta species reported by Yılmaz et al. (16), Erk'akan (32), and Ekmekçi (3), while they were lower than those of *C. trutta* reported by Gül et al. (20). The differences in conditions may have resulted from the species differentiation, feeding activities and ecological conditions such as water temperature, feeding and food abundance. It was determined that the condition factors of the stream populations were higher than those of the reservoir populations (Table 4). This situation may have resulted from fish sizes. The samples obtained from the reservoirs were bigger than those of the stream populations, and condition factors decreased at the older ages.

Consequently, it was determined that the growth of *C.c. angorae* in the River Ceyhan Basin was affected positively by the construction of the reservoir and commercial fishery values of this species has been increased. However, spawning migration was stopped due to the dams and lack of fish passage and so, in addition to this study, the reproduction biology of this species should be investigated in detail and some conservation measures should be taken.

Acknowledgments

We would like to thank the two anonymous referees for their helpful suggestions, which considerably improved the manuscript. We also thank Prof. Dr. Süleyman BALIK for his valuable comments on the taxonomic position of the fish species.

References

1. Alp, A., Büyükçapar, H.M., Eren, A.,: Menzelet Baraj Gölü (Kahramanmaraş) balıkçılığı ve ekonomik olarak avlanan balık türleri. KSÜ Fen Mühen. Derg., 2003; 6:142-153.
2. Türkmen, M., Erdoğan, O., Yıldırım, A., Akyurt, İ.: Reproduction tactics, age and growth of *Capoeta capoeta umbla* Heckel 1843 from the Aşkale Region of Karasu River, Turkey. Fish. Res., 2002; 54: 317-328.
3. Ekmekçi, F.G.: Sarıyer Baraj Gölü'nde (Ankara) yaşayan *Capoeta tinca* (Heckel 1843)'nın büyüme ve üreme özellikleri. Turk. J. Zool., 1996; 20: 117-126.
4. Ekmekçi, F.G.: Sarıyer Baraj Gölü'nde (Ankara) yaşayan *Capoeta capoeta sieboldi* (Steindachner, 1897)'nın bazı büyüme özellikleri. Turk. J. Zool., 1996; 20: 127-136.
5. Başusta, N., Erdem, Ü.: Aslantaş ve Mehmetli (Adana) Baraj Göllerinde yaşayan *Capoeta barroisi* (Lortet, 1984) türünün büyüme parametrelerinin incelenmesi. Doğu Anadolu Bölgesi I (1993), ve II (1995) Su Ürünleri Sempozyumu, Erzurum. 1996; 672-681.
6. Cengizler, İ., Erdem, Ü.: Almus Baraj Gölü'nde (Tokat) yaşayan iki Cyprinid türünün (*Barbus plebejus* Bonaparte, 1832, *Capoeta tinca* Heckel, 1843) büyüme performansları üzerine bir araştırma. XII. Ulusal Biyoloji Kongresi, Hidrobiyoloji seksiyonu, Edirne. 1994; 36-42.
7. Şen, D.: Kalecik (Karakoçan-Elazığ) Göleti'nin ve su ürünlerinin incelenmesi. Doğa Türk Biyol., 1988; 12: 69-85.
8. Özdemir, N.: Elazığ-Hazar Gölü'nde bulunan *Capoeta capoeta umbla*'nın (Heckel, 1843) ekonomik değeri ve yetiştirme olanaklarına ilişkin biyolojik özellikler. Doğa Bilim Derg. Vet. Hay./ Tar. Orm., 1982; 6: 67-75.
9. Şen, F., Çetinkaya, O., Elp, M.: Nazik Gölü (Ahlat-Bitlis) Siraz (*Capoeta capoeta*,Guldenstaedt, 1773) populasyonu üzerine bir araştırma. X. Ulusal Su Ürünleri Sempozyumu, Adana. 1999; 465-475.
10. Canbolat, A.F., Yerli, S.V., Çalışkan, M.: Çıldır Gölü'ndeki (Ardahan) *Capoeta capoeta capoeta* (Guldenstant, 1773)'nın büyüme özelliklerinin incelenmesi. Turk. J. Zool., 1999; 23: 225-232.
11. Geldiay, R., Balık, S.: Türkiye tatlı su balıkları. Ege Üniversitesi Fen Fak. Kitaplar Serisi No: 97, 520 s., 1988.
12. Balık, S.: Freshwater fish in Anatolia, Turkey. Biologic. Conservat., 1995; 72: 213-223.
13. Korkmaz, A.Ş., Atay, D.: Şuğul Deresi sarıbalıklarının (*Capoeta capoeta umbla* Heckel, 1843) yaş ve büyüme özellikleri. X. Ulusal Su Ürünleri Sempozyumu, Adana.1999; 476-485.
14. Akgül, M.: Kızılırmak Havzası'nda yaşayan *Capoeta tinca* (Heckel, 1843)' nın biyo-ekolojisi üzerine araştırmalar. Türkiye VIII. Ulusal Biyoloji Kongresi, Hidrobiyoloji Seksiyonu, İzmir. 1987; 599-613.
15. Akgül, M.: Kelkit Çayı'nda yaşayan siraz balığının, *Capoeta tinca* Heckel 1843, büyüme oranları, kondüsyon faktörü ve üreme peryodu üzerine bir araştırma. IX Ulusal Biyoloji Kongresi Tebliğ Özetleri, Sivas. 1988; 101 s.
16. Yılmaz, M., Gül, A., Solak, K.: Sakarya Nehri - Kirmir Çayı'nda yaşayan in balığı (*Capoeta tinca* Heckel 1843)'nın bazı biyolojik özelliklerinin incelenmesi. Turk. J. Zool., 1996; 20: 349-356.
17. Yıldırım, A.: Oltu Çayı (Çoruh Nehri)'nın bazı parametrelerindeki yıllık değişimler ve bu suda yaşayan *Capoeta tinca* (Heckel,1843) (Pisces-Siraz balığı) balığının biyo-ekolojisi ile et analizleri üzerine araştırmalar. Doktora Tezi, Atatürk Üniv. Fen Bil. Ens., Erzurum. 1997; 107 s.
18. Ünlü, E. : Dicle Nehri'nde yaşayan *Capoeta trutta* (Heckel, 1843)' nın biyolojik özellikleri üzerine çalışmalar. Doğa Turk J. Zool. 1991; 15: 22-38.
19. Şevik, R.: Aşağı Fırat sularında yaşayan *Capoeta trutta* (Heckel, 1843)'nın büyüme durumu ve üreme özellikleri üzerine araştırmalar. Doğu Anadolu Bölgesi I (1993), ve II (1995) Su Ürünleri Sempozyumu, Erzurum. 1995; 172-200.
20. Gül, A., Yılmaz, M., Solak, K.: Fırat Nehri Tohma Suyu'nda yaşayan *Capoeta trutta* (Heckel, 1843)'nın büyüme özellikleri. Turk. J. Zool., 1996; 20: 177-185.
21. Erdoğan, O.: Aras Nehri'nde yaşayan *Capoeta capoeta capoeta* (Güldenstaedt, 1772) balığının büyüme ve üreme özellikleri ile avlanma bölgesi suyunun bazı fiziko-kimyasal parametrelerinin araştırılması. Doktora Tezi. Atatürk Üniv. Fen Bil. Ens., Erzurum. 1988; 93 s.
22. Alp, A., Kara, C., Büyükçapar, H.M., Bülbül, H.M.: Tekir ve Fırnız çaylarında (Kahramanmaraş) yaşayan balık populasyonları ve biyolojik özellikleri. Kahramanmaraş Sütçü İmam Üniversitesi, Araştırma Fonu Proje Sonuç Raporu. Proje No: 1997/7-1/1, 94 s., 2002.
23. Alp, A., Kara, C., Büyükçapar, H.M.: Reproductive biology of brown trout, *Salmo trutta macrostigma* Dumeril, 1858, in a tributary of the Ceyhan River which flows into the East Mediterranean Sea. J. Appl. Ichthyol., 2003; 19: 346-351.
24. Alp, A., Kara, C., Büyükçapar, H.M.:Reproductive biology in a native European catfish, *Silurus glanis* L., 1758, population in the Menzelet Reservoir. Turk. J. Vet. Anim. Sci., 2004; 28: 613-622.
25. Paksoy, M.F.: Menzelet Baraj Gölü'nde (Kahramanmaraş) fizikokimyasal özellikler, zooplanktonik organizmaların tür çeşitliliği, yoğunluğu ve mevsimsel dağılımı. Yüksek Lisans Tezi. Kahramanmaraş Sütçü İmam Üniversitesi Fen Bil. Ens., Kahramanmaraş. 2002; 69 s.
26. Chugunova, N.I.: Age and gowth studies in fish (Trans. From. Russian). Israel Program for Scientific Translations Ltd. 1959; 132 p.
27. Özdamar, K.: Paket programlar ile istatistiksel veri analizi 1. Kaan Kitabevi 2. Baskı, No: 1, ISBN 975-6787-00-7. 1999.

28. Sparre, P., Venema, S.C.: Introduction to tropical fish stock assessment. FAO Fisheries Technical Paper 306 / 1, Rev., 137 p., 1992..

29. Gayanilo, J.F.C., Sparre, P., Pauly, D.: The FAO-ICLARM stock assessment tools (FISAT) User's guide. FAO computerized information series: fisheries. ICLARM Contribution, 1048, 126 p., 1995.

30. Pauly, D., Munro, J.L.: Once more on the comparison of growth of growth in fish and invertebrates. ICLARM Fishbyte, 2, 21 p., 1984.

31. Girgin, A., Öztürk, S., Emiroğlu, S., Şen, D.: Karakaya Baraj Gölü'nde yaşayan *Capoeta capoeta umbla* (Heckel, 1843)'da büyüme özellikleri. IX. Ulusal Su Ürünleri Sempozyumu, 17-19 Eylül, Eğirdir. 1997; 98-109.

32. Erk'akan, F.: Sakarya Havzası balıklarının (Pisces) sistematiği ve biyoekolojik ilişkileri üzerine araştırmalar. Doktora Tezi, Hacettepe Üniv. Fen Bil. Ens., Ankara, 144 s., 1981.

33. Ekingen, G., Polat, N.: Age determination and length-weight relations of *Capoeta capoeta umbla* (Heckel) in Lake Keban. Doğa Türk Zool., 1987; 11: 5-15.