Journal of Fisheries
Volume 8 Issue 2 Pages 823–827 August 2020
Peer Reviewed | Open Access | Online First

eISSN 2311-3111
pISSN 2311-729X

Original Article

Age, length-weight relationships and condition factors of endemic Antalya barb *Capoeta antalyensis* (Battalgil, 1943)

Soner Çetinkaya[1,2] • Rahmi Uysal[1] • Vedat Yegen[1] • Mustafa Ceylan[1] • Ufuk Akçimen[3] • Fuat Bilgin[1]

[1]*Republic of Turkey Ministry of Agriculture and Forestry, Fisheries Research Institute, Eğirdir, Isparta, Turkey*

[2]*Republic of Turkey Ministry of Agriculture and Forestry, Mediterranean Fisheries Research, Production and Training Institute, Antalya, Turkey*

[3]*Republic of Turkey Ministry of Agriculture and Forestry, County Directorate, Eğirdir, Isparta, Turkey*

Correspondence
Soner Çetinkaya; Republic of Turkey Ministry of Agriculture and Forestry, Fisheries Research Institute, Eğirdir, Isparta, Turkey.

cetinson_70@hotmail.com

Manuscript history
Received 21 January 2020 | Revised 8 May 2020 | Accepted 12 May 2020 | Published online 26 May 2020

Citation
Çetinkaya S, Uysal R, Yegen V, Ceylan M, Akçimen U, Bilgin F (2020) Age, length-weight relationships and condition factors of endemic Antalya barb *Capoeta antalyensis* (Battalgil, 1943). Journal of Fisheries 8(2): 823–827.

Abstract

The aim of this study was to determine the length-weight, length-length relationships (LWR and LLR) and condition factors of Antalya barb *Capoeta antalyensis*, an endemic species to Turkey. The specimens (N = 125) were caught using the gill nets in the Sorgun Dam (Aksu, Isparta). The age of the study specimens varied between one and six years. The total length and body weight of the specimens varied from 17.7 – 36.7 cm and 57.03 – 526.91 g respectively. A negative allometric growth (b = 2.7743) was recorded for the species whereas the LWR and total length (TL) – fork length (FL) equations were $W = 0.0203 \times TL^{2.7743}$ (R^2 = 0.95) and $TL = 0.402 + FL \times 1.061$ (R^2 = 0.99) respectively. The condition factor was determined for every specimen. In light of the results obtained in the study this species may be considered for aquaculture ensuring sustainable population in the wild. This study provides new information that can play an important role in the sustainable management this species.

Keywords: Endemic fish; negative allometry; LWR; LLR; condition factor; sustainable management

1 | INTRODUCTION

Fish may exhibit growth characteristics that may vary depending on the characteristics of the aquatic environment in which they live. Since the beginning of the 20th century, fisheries research has used this variability in length–weight (LWR), length–length (LLR) relationships and condition factors based on the assumption that fish of a certain length are heavier than others to compare the condition, fatness or welfare of fish (Froese 2006; Yilmaz *et al.* 2010). Investigating these relationships are commonly used methods in fisheries biology and population dynamics to determine the population structure and stock status of a species (Bagenal and Tesch 1978). With these relationships, it is possible to estimate the length or weight of a fish from its length using mathematical equations or to compare its populations in different waters. With the LWRs, populations can be used rationally and sustainably (Pervin and Mortuza 2008). It is also used to determine the tendency of fish growth (*e.g.* isometric and allometric) (Le Cren 1951; Ricker 1975). The LLRs are used in the

conversion and comparison of length values obtained by different length measurements of fish (Moutopoulos and Stergiou 2002). When only fish length data are available, fish weight and biomass can be determined using the LWR equation (Le Cren 1951; Koutrakis and Tsikliras 2003). The LLR is particularly important in achieving the desired length value (total, fork, standard) in studies using different length values (Moutopoulos and Stergiou 2002).

Around the world, 65 species belonging to the genus *Capoeta* have been identified in 51 countries or regions on four continents *viz.* Africa, America, Asia and Australia (Froese and Pauly 2019). In Turkey, 23 species of genus *Capoeta* are distributed in various water bodies (Yeğen *et al.* 2006; Fricke *et al.* 2007; Küçük *et al.* 2009; Froese and Pauly 2019) and is widely consumed as food fish due to its delicious taste. However, commercial catching of these species is very limited as this species has not systematically been commercially evaluated processing industries. While this species is defined as Endangered according to the IUCN criteria (Turan and Özcan 2009) Freyhof (2014) classified as Vulnerable. The aim of this study was to determinate the seasonal variation in LWR, LLR and condition factor of *C. antalyensis* (Battalgil, 1943) with a view to contributing to the population management of the species. This would also shed light on the future studies on this species.

2 | METHODOLOGY

The Antalya barb *C. antalyensis* (Figure 1) is distributed in some parts of the Lakes Region basin, commonly available in all parts of the rivers between the Boğa Çayı Stream in the west of Antalya and the Peri Köprüsü near Manavgat (Koca 2011). This species prefers sandy and gravel beds in the river and reproduction occurs between May and June (Küçük and İkiz 2004).

FIGURE 1 The Anatalya barb *Capoeta antalyensis*.

The body of the species has an oval appearance. Head length is always higher than body height. The mouth is somewhat inferior and half-moon shaped. The final spiny fin rays of the dorsal fin are not well developed and can easily be bent. The caudal fin is deeply forked and has sharp edges. There are two pairs of barbels around the mouth. It differentiated apart from the *Capoeta tinca* species by the number of perforated scales on the lateral line (48 – 56), the number of vertebrae (43 – 45) and poor development of the dorsal fin of the last soft beam (Küçük and İkiz 2004).

In order to determine the changes in LWRs, LLRs and condition factors, a single sampling was carried out at Sorgun Dam in each of the four seasons. The gill nets of different mesh sizes (16 × 16, 20 × 20, 25 × 25, 30 × 30, 35 × 35, 40 × 40 mm) were used during sampling (Özekinci *et al.* 2003) to ensure catches of all age classes. A total of 125 fish specimens captured during this time including 31 in spring, 10 in summer, 23 in autumn and 61 in winter. The population of the species at the sampling site was unknown (size, structure, nutrition, reproduction etc.). Therefore, one time sampling was conducted in order ensure minimum damage to the existing population.

The age of the fish specimens was determined analysing the scales. For this purpose, the scales near the operculum, above lateral line on the left side of the fish were removed and prepared following Lagler (1966). Samples were examined using Nikon Profile Projector V-10 (Japan) and their age was determined by counting the age rings (*i.e.* annuli). The total length (TL), standard length (SL) and fork length were measured by standard device. Fish body weight (g) was determined using a digital balance (to the nearest 0.01 g). The LWRs were determined by the following equation, $W = aL^b$ (W, weight in g; L, total length in cm; a, constant; b, constant) (Bagenal and Tesch 1978). The LLRs were established using TL = a + FL b, FL = a + SL b, and SL = a + TL b, where a and b are constant values obtained through linear regression (Yılmaz *et al.* 2010). The Fulton's condition factor was calculated using the equation $K = 100 \times W / L^3$ (W, weight; L, total length; Simon and Mazlan 2008). The relative condition factor was also determined using the formula $K_n = W / W'$ where W is the weight and W' is the estimated weight of the individual through LWR (Le Cren 1951).

3 | RESULTS

3.1 Length and weight distributions and age

Out of 125 specimens considered 79 were female and 43 were male. The gender of three individuals could not be calculated due to their immature gonads. The ages of the fish specimens ranged from 1 (recorded in spring) to 6 (recorded in summer) years. The lowest total length was 17.7 cm, recorded in spring whereas the largest specimen was 36.7 cm, captured in summer (Table 1). The lowest and highest body weights were 57.03 and 526.91 g respectively, recorded in spring.

3.2 LWR, LLR and condition factors

The LWR and LLR equations of the population calculated from the individuals obtained in the study are given in Table 2. The highest and lowest Fulton's condition factors were recorded in individuals caught in spring (Table 3). The mean Fulton's condition factor was 0.99 whereas the relative condition factor was 1.00 for all individuals.

3 | DISCUSSION

In this study the fish specimens were collected from Sorgun Dam (Aksu, Isparta) using gill nets of varying mesh sizes. The age of the specimens ranged from 1 to 6 years in which 1-year-old individuals were obtained in spring and 6-year-old fish were obtained in summer. Koca (2011) reported the age range of this species as 0 – 4 years in Aksu stream. The total length and weight of *C. antalyensis* individuals varied from 17.7 – 36.7 cm and 57.03 – 526.91 g respectively. However, the smaller individuals of the species could not be obtained due to obstacles on the banks such as trees and bushes prevented the research team from using seine-net or fyke net effective in catching small individuals. This species prefers sandy, gravel and even rocky beds in the water body with clear water. In addition to the sampling efforts of this study attempts have also been made using electro-shocker in the estuary region to obtain small individuals but they were not successful. The stream (Bağıcık Brook) feeding the dam flows through a plain. It may be assumed that the small individuals were feeding in the upper parts of this stream. However, the highest length and weight recorded in this study were higher than those reported for this species earlier. The fish weight from 4.11 – 237.27 g and fork length of 6 – 27.1 cm were reported in Aksu Stream (Koca and Ölmez 2010). They also reported an asymptotic length (L_∞) of 35.73 cm and asymptotic wet weight (W_∞) of 837.75 g. The findings of this study (Table 1) are greater than L_∞ and smaller than W_∞ reported by Koca and Ölmez (2010). Ayyildiz *et al.* (2015) recorded the highest total length of 34 cm among individuals of the Aksu Stream. The length and weight values obtained in both studies for the *C. antalyensis* species in the Aksu Stream, where Sorgun Dam water discharges, were smaller than the findings of this study.

TABLE 1 The seasonal variation in age, length and weight (average ± SE, range) of *Capoeta antalyensis*.

Seasons	*N*	Total length (cm)	Fork length (cm)	Standard length (cm)	Weight (g)	Age range (year)
Spring	31	24.66 ± 0.92 (17.7 – 36.5)	22.26 ± 0.83 (15.7 - 33.2)	20.35 ± 0.77 (14.5 – 30.4)	163.07 ± 20.00 (57.03 – 526.91)	1 – 5
Summer	10	26.45 ± 1.91 (19.9 – 36.7)	23.81 ± 1.78 (17.2 – 33.2)	20.92 ± 1.61 (15.2 – 29.5)	195.20 ± 43.04 (75.00 - 452.00)	3 – 6
Autumn	23	24.92 ± 0.44 (19.8 – 36.7)	22.27 ± 0.40 (17.2 – 33.2)	19.52 ± 0.33 (15.6 – 29.5)	150.28 ± 7.07 (72.12 – 223.28)	2 – 5
Winter	61	24.73 ± 0.33 (19.8 – 33.1)	22.31 ± 0.31 (17.7 – 30.4)	20.58 ± 0.29 (16.4 – 28.2)	157.55 ± 6.82 (85.21 – 341.56)	2 – 5

TABLE 2 The length-weight relationship (LWR) and length-length relationships in *Capoeta antalyensis*. *TL*, total length; *FL*, fork length; and *SL*, standard length.

Relationship	Formula	R^2
LWR	$W = 0.0203 \times TL^{2.7743}$	0.9538
TL–FL	$TL = 0.402 + 1.061\ FL$	0.9862
FL–SL	$FL = 1.169 + 1.008\ SL$	0.9684
SL–TL	$SL = -0.636 + 0.884\ TL$	0.9596

TABLE 3 Fulton's and relative condition factors of *Capoeta antalyensis*.

Values	Sample types				
	Spring	Summer	Autumn	Winter	Pooled
Fulton's condition factor					
Lowest	0.64	0.78	0.82	0.86	0.64
Highest	1.16	0.97	1.05	1.15	1.16
Mean	0.99	0.92	0.97	1.01	0.99
Relative condition factor					
Lowest	0.70	0.77	0.80	0.88	0.70
Highest	1.26	1.02	1.07	1.19	1.26
Mean	1.00	0.95	0.96	1.03	1.00

Among the growth parameters, the *b* value recorded in this study (2.7743) was similar to Innal (2014) (*b* = 2.946) and Ayyildiz *et al.* (2015) (*b* = 2.935) indicating a negative allometric growth while the values obtained by Koca and Ölmez (2010) and Koca (2011) (both *b* > 3) resembled a positive allometric growth. Female individuals were dominant proportionally in Sorgun Dam (female 63.2%, male 34.4%, undetermined 2.4%). A similar sex ratio (57.14% female and 42.86% male) was also recorded for *Capoeta capoeta angorae* individuals in the Köprüçay River (Özvarol *et al.* 2008). In our study, all the LWR and LLRs showed very high level of correlations (all $R^2 > 0.95$).

The condition factors, also known as the fattening coefficient, were determined separately for individuals caught in different seasons which show little differences in fish growth across seasons. Both condition factors are quite close to ideal (*K* = 1). In this study, the lowest (*K* = 0.64) and the highest (*K* = 1.16) Fulton' condition factors were obtained in spring. The mean condition factors resembled that the *C. antalyensis* individuals did not suffer from nutritional deficiency in Sorgun Dam Lake. Condition factor values obtained by Koca (2011) were higher than the present findings.

5 | CONCLUSIONS

The length and weight values obtained in this study are the highest values ever obtained for the Antalya barb *Capoeta antalyensis*. This study also reports findings from a lentic habitat whereas previous studies are based on lotic habitats. The condition factors of *C. antalyensis* indi-

viduals indicate good feeding conditions in Sorgun Dam Lake with little seasonal variation. In light of the data obtained in the study, this species may be considered a new candidate for aquaculture but sustainable population in the wild should be ensured. This study provides new information that can play an important role in the population and stock management of *C. antalyensis*.

ACKNOWLEDGEMENT

This study was supported financially by Republic of Turkey Ministry of Agriculture and Forestry General Directorate of Agricultural Research and Policies (Project Number: TAGEM/HSGYAD/16/A05/P03/114).

CONFLICT OF INTEREST

The author declares no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

REFERENCES

Ayyildiz H, Emre Y, Yagci A, Altin A (2015) Length-weight relationships of eight freshwater (Cypriniformes) fish species from Turkey. Journal of Applied Ichthyology 31: 963–964.

Bagenal TB, Tesch FW (1978) Age and growth. In: Bagenal TB (Ed) Methods for assessment of fish production in fresh waters, 3rd edition. Blackwell Scientific Publications, Oxford.

Freyhof J (2014) *Capoeta antalyensis*. The IUCN Red List of Threatened Species 2014: e.T3784A19006247. Downloaded on 28 April 2020.

Fricke R, Bilecenoğlu M, Sari HM (2007) Annotated checklist of fish and lamprey species (Gnathostomata and Petromyzontomorphi) of Turkeyi including a red list of threatened and declining species. Staatliches Museum für Naturkunde, Rosenstein 1, D-70191 Stuttgart. Ser. A, Nr. 706, 169, 3 Abb., 8 Tab. Stuttgart.

Froese R (2006) Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology 22: 241–253.

Froese R, Pauly D (Eds) (2019) FishBase. World Wide Web electronic publication. www.fishbase.org version (12/2019). Retrieved on 4 September 2019.

Innal D (2014) Identifying growth parameters for two endemic species [*Capoeta antalyensis* (Battalgil, 1943) and *Pseudophoxinus antalyae* Bogutskaya, 1992] in Duden Creek, Antalya, Turkey. Journal of Applied Ichthyology 30: 294–299.

Koca HU (2011) Aksu Çayı-Köprüçay Nehri (Isparta-Türkiye) balık populasyonlarının dinamiğinin incelenmesi. Dissertation, Süleyman Demirel University (in Turkish).

Koca HU, Ölmez M (2010) The characteristics of growth *Capoeta antalyensis* (Battalgil, 1944) population in Aksu Stream (Isparta-Turkey). Süleyman Demirel Üniversitesi, Fen Bilimleri Enstitüsü Dergisi. 14(3): 229–234.

Koutrakis ET, Tsikliras AC (2003) Length-weight relationships of fishes from three northern Aegean estuarine systems (Greece). Journal of Applied Ichthyology 19: 258–260.

Küçük F, İkiz R (2004) Antalya fish fauna of streams discharging to Antalya Bay. E.U. Journal of Fisheries and Aquatic Sciences 21(3–4): 287–294.

Küçük F, Turan D, Şahin C, Gülle İ (2009) *Capoeta mauricii* n. sp., a new species of cyprinid fish from Lake Beyşehir, Turkey. Zoology in the Middle East 47(1): 71–82.

Lagler LK (1966) Freshwater fishery biology. W.M.C. Brown Company, Iowa.

Le Cren ED (1951) The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology 20: 201–219.

Moutopoulos DK, Stergiou KI (2002) Length-weight and length-length relationships of fish species from the Aegean Sea (Greece). Journal of Applied Ichthyology 18: 200–203.

Özekinci U, Beğburs CR, Tenekecioğlu T (2003) An investigation of gill nets selectivity used in *Capoeta capoeta umbla* (Heckel, 1843) and *Capoeta trutta* (Heckel, 1843) (Siraz fish) fishery in Keban Dam Lake. E.U. Journal of Fisheries and Aquatic Sciences 20: 473–479.

Özvarol ZAB, Özvarol Y, Taşli A (2008) The determination of age, growth characteristics and the sexual maturity of *Capoeta capoeta angorae* (Heckel, 1843) inhabiting Sağırın Stream, River of Köprüçayı (Antalya). Su Ürünleri Mühendisleri Derneği Dergisi. 32: 48–53 (in Turkish).

Pervin MR, Mortuza MG (2008) Notes on length-weight relationship and condition factor of fresh water fish, *Labeo boga* (Hamilton) (Cypriniformes: Cyprinidae). University Journal of Zoology Rajshahi University 27: 97–98.

Ricker WE (1975) Computation and interpretation of bioogical statistics of fish populations. Bulletin of the Fisheries Research Board of Canada. Book No. 191. The Blackburn Press, New Jersey.

Simon KD, Mazlan AG (2008) Length-weight and length-length relationships of archer and puffer fish species. The Open Fish Science Journal 2008(1): 19–22.

Turan C, Özcan G (2009) Threatened fishes of the world: *Capoeta antalyensis* (Battalgil, 1943) (Cyprinidae). Environmental Biology of Fishes 84: 243–244.

Yeğen V, Balik S, Ustaoğlu MR, Sari HM, İlhan A, Uysal R, Bostan H, Bilçen E, Yağci A (2006) Göller bölgesi balık faunasının tespiti. Project Report. TAGEM / HAYSÜD / 2001/09/02/01 (in Turkish).

Yilmaz Ş, Yazicioğlu O, Yilmaz M, Polat N (2010) Length-weight and length-length relationships, and seasonal condition factors of *Cyprinus carpio* L., 1758 and *Tinca*

tinca (L., 1758) inhabiting Hirfanlı dam lake. Süleyman Demirel University Journal of Science (E- Journal) 5(2): 154–162.

CONTRIBUTION OF THE AUTHORS

SÇ research design, fish sampling, laboratory work, research design, data analysis and manuscript preparation;
RU fish sampling, laboratory work;
VY fish sampling, laboratory work;
MC fish sampling, laboratory works;
UA fish sampling, laboratory works;
FB fish sampling, laboratory works.

S Çetinkaya https://orcid.org/0000-0003-2877-1248
R Uysal https://orcid.org/0000-0002-7342-9380
V Yegen https://orcid.org/0000-0001-5349-1497
M Ceylan https://orcid.org/0000-0002-3283-0637
U Akçimen https://orcid.org/0000-0003-3380-3603
F Bilgin https://orcid.org/0000-0002-2307-3611