




Population structure and some growth properties of chub *Squalius cephalus* (Linnaeus, 1758) in Devres Stream of Kızılırmak River, Turkey

Semra Benzer • Ali Gül

Gazi University, Gazi Faculty of Education, Teknikokullar 06500 Ankara, Turkey.

Correspondence

Dr Semra Benzer; Gazi University, Gazi Faculty of Education, Teknikokullar 06500 Ankara, Turkey.

 sbenzer@gazi.edu.tr and sbenzer@gmail.com

Manuscript history

Received 23 March 2017 | Revised 5 September 2017 | Accepted 8 September 2017 | Published online 11 Nov 2017

Citation

Benzer S and Gül A (2017) Population structure and some growth properties of chub *Squalius cephalus* (Linnaeus, 1758) in Devres Stream of Kızılırmak River, Turkey. *Journal of Fisheries* 5(3): 513–518. DOI: 10.17017/jfish.v5i3.2017.247

Abstract

This study describes the population structure, growth and condition factor of chub (*Squalius cephalus*) in Devres Stream of Kızılırmak River caught between June 2010 and June 2011. *S. cephalus* individuals ranging between I and VI years old were caught from Devres Stream. Studied individuals were between I and VI years old and their sex was determined as 51.67% male and 48.33% female. The fork length and body weight ranged from 8.79 – 19.64 cm and 9.73 – 126.60 g respectively. The von Bertalanffy growth equations were found: $L_t = 27.163 [1 - e^{-0.159(t+1.47)}]$ for females and $L_t = 27.078 [1 - e^{-0.160(t+1.46)}]$ for males; $W_t = 286.14 [1 - e^{-0.159(t+1.47)}]^{3.1049}$ for females and $W_t = 284.43 [1 - e^{-0.160(t+1.46)}]^{2.9692}$ for males. The condition factor was calculated as 1.432 and 1.378 for females and males respectively.

Keywords: *Squalius cephalus*; chub; growth; von Bertalanffy's parameters; Devres Stream; Kızılırmak River.

1 | INTRODUCTION

The chub *Squalius cephalus* (Linnaeus, 1758), members of the family Cyprinidae, are common and widely distributed in Europe and Asia. One of the possible reasons for that is the high environmental tolerance of the chub (Arlinghaus and Wolter 2003). This species is usually investigated as an unpretentious species which occurs commonly in localities with different conditions, both natural and artificial ones (Arlinghaus and Wolter 2003). Since it is consumed as food by the locals, the *S. cephalus* has economic value; therefore, in order to take better advantage of the populations of this species, it is important to understand its growth and reproduction characteristics. Some authors have worked on its growth in connection with its usual occurrence of fish species. Many studies have been carried out on age and growth properties of the *S. cephalus*

(Lelek 1959; Vostradovský 1961; Leontovyč 1974; Habasby 1974; Leontovyč 1980; Hanel 1982 1984; Švátora and Pivnička 1986 1989; Altındağ 1996; Ünver 1998, Türkmen *et al.* 1999; Geldiay and Balık 1999; Vlach and Švátora 2000; Vlach and Švátora 2000; Sası and Balık 2003; Kara and Solak 2004; Balık *et al.* 2004; Karatas and Can 2005, Koc *et al.* 2006; Kirankaya and Ekmekçi 2007, Stefanova *et al.* 2008; Şen and Saygın 2008; Bostancı and Polat 2009; İnnal 2010; Pompei *et al.* 2011; Dirican and Çilek 2012; Bulut *et al.* 2012; Sedaghat *et al.* 2012; Ünver and Erk'akan 2012; Raikova-Petrova *et al.* 2012; Özay 2014; Kaptan 2014; Çicek *et al.* 2016; Kılıç and Becer 2017).

The aim of this study is to determine the age composition, sex ratio, length and weight growth, the length-weight relationship, and the condition factor of *S. cephalus* in Devres Stream, Kızılırmak River. This study is very

important in determining the growth characteristics of the *S. cephalus* which is very common in the domestic waters of this water system which is rich in biodiversity.

2 | METHODOLOGY

Devres Stream is a branch of the Kızılırmak River, geographically located in the Western Black Sea Region of Turkey. Devres Stream is located about 70 km south of Kastamonu, and lies within the coordinates of 35°49'00" N to 42°35'00" N latitudes and 25°00'00" E to 44°51'00" E longitudes. A total of 329 *S. cephalus* (159 females and 170 males) were collected between June 2010 and June 2011 from the Devres Stream, Kızılırmak River by using a gill net (18–55 mm mesh). Collected specimens were transported to the laboratory to record the fork length (FL) to the nearest 0.1 cm and body weight (BW) to the nearest 0.1 g. Scales were sampled from each specimen for age determination according to Lagler (1966).

Growth was estimated using the von Bertalanffy growth curve model (Sparre and Venema 1992) $L_t = L_{\infty}[1 - e^{-k(t-t_0)}]$ and weight $W_t = W_{\infty}[1 - e^{-k(t-t_0)}]^b$ where L_t = the fork length (cm) at age t , L_{∞} = the asymptotic length (theoretical maximum length), k = the Brody growth coefficient (proportional to rate at which L_{∞} is reached), t = the age (years), t_0 = the age at zero length, e is the base of natural log (2.71828), W_t is the weight of the fish in g at age t , W_{∞} is the asymptotic weight of (theoretical maximum weight) the fish in g and b is the constant in the length–weight relationship. The von Bertalanffy growth parameters were estimated for males and females separately as well as for both sexes combined. The relationship between FL and

BW was calculated separately for each sex with \log_{10} -transformed data (Le Cren 1951). The condition factors (CF) of fish was determined using the formula $(W L^{-3}) \times 100$ (Ricker 1975) where W = body weight and L = body length. t -test was performed to test if there were significant differences between the length, weight and condition factor of females and males. Statistical analysis of the data was carried out using SPSS statistical package program for Windows (Version 20.0).

3 | RESULTS

Collected specimens of *S. cephalus* were aged from I to VI years and dominated by the first and second year classes. There were 48.33% females and 51.67% males (ratio 1 : 1.07), and differences in their numbers among different age groups was insignificant ($t = 2.509$; $P > 0.05$).

The mean FL, mean W and CF of male and female fish in different age groups are presented in Table 1. Males in all age groups were longer than females. The differences between the sexes were insignificant in all groups ($t = 2.215$; $P > 0.05$). Age–length relationships of females and males were plotted in Figure 1 with the respective equations indicated and differences between sexes were insignificant in all age groups ($t = -1.963$; $P > 0.05$). Male and female age–weight relationships were drawn in Figure 2. While the weight of the females was higher than that of the males in age groups III and V, the weight of the males was higher than that of the females in age groups I, II, IV and VI. Females grew to a greater asymptotic (W_{∞}) weight than the males (Figure 3).

TABLE 1 Fork length, weight and condition factor of *Squalius cephalus* in Devres Stream

Age	N	Male			N	Female		
		FL ± SE	W ± SE	CF ± SE		FL ± SE	W ± SE	CF ± SE
I	43	8.90±0.84	10.18±2.66	1.42±0.16	27	8.79±0.99	9.73±3.24	1.40±0.29
II	84	11.33±0.94	20.03±6.66	1.35±0.26	65	11.21±0.83	19.95±4.78	1.40±0.15
III	27	13.49±1.22	32.44±6.43	1.34±0.33	41	13.56±1.54	36.42±14.39	1.41±0.18
IV	7	16.57±1.24	55.43±8.98	1.33±0.24	13	15.93±0.90	61.42±18.70	1.37±0.22
V	4	17.95±0.29	91.62±31.62	1.57±0.47	7	18.00±0.28	100.85±22.03	1.72±0.30
VI	5	19.64±0.86	121.83±19.88	1.68±0.26	6	18.82±0.82	126.60±18.77	1.85±0.37

N, number of fish; FL, Fork length (cm), W, Weight (g) and CF, Condition factor (all $P > 0.05$)

Length–weight relationships (Figure 3) were calculated using the data of all fish samples. The relationship was $W = 0.01463008 L^{2.9692}$ ($R^2 = 0.900$) for the males and $W = 0.01089046 L^{3.1049}$ ($R^2 = 0.913$) for the females. The b value for the females was higher than that of the males. While CF of the females was higher than that of the males

in age groups II, III, IV, V and VI, CF of the males was higher than that of the females in age group I. The differences between sexes were insignificant ($t = 2.215$, $P > 0.05$; Table 1). The condition factor was calculated as 1.432 and 1.378 for the females and males respectively.

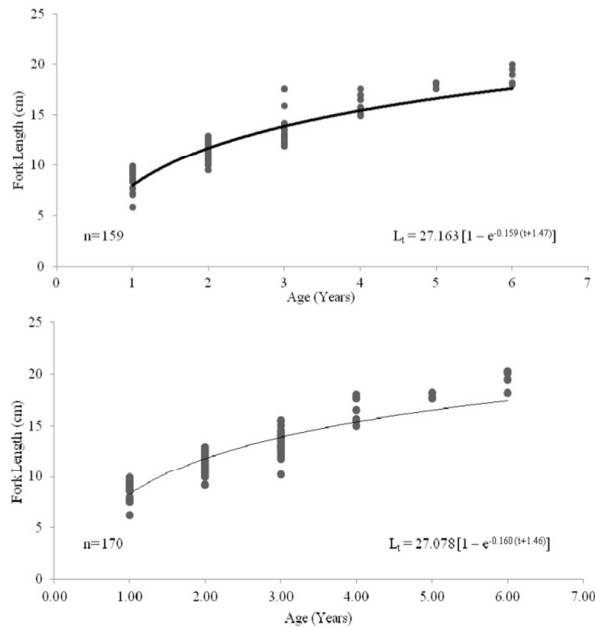


FIGURE 1 Age-length relationships in female (above) and male (below) *Squalius cephalus*

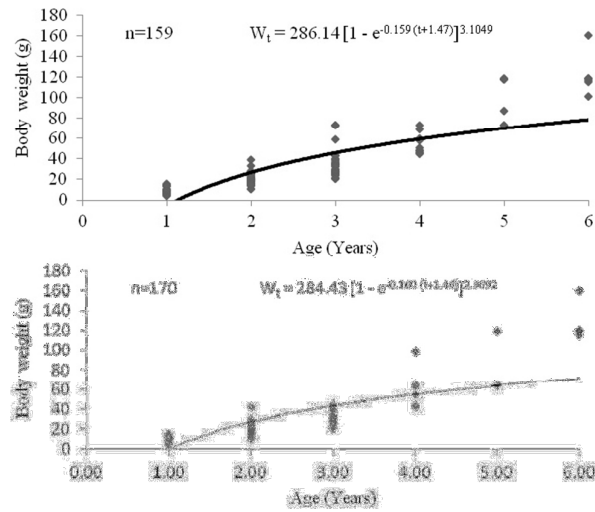


FIGURE 2 Age-weight relationships in female (above) and male (below) *Squalius cephalus*

4| DISCUSSION

The female male sex ratio (F : M) of the chub in Devres Stream was 1 : 1.07, and similar to the 1 : 1 ratio expected for most fish species (Bagenal and Tesch 1978). The sex ratios for this species from different habitats in the world and Turkey were determined as 1 : 2.85 in the Istranca Stream (Kaptan 2014), 1.6 : 1 in the Akçay/Muğla (Özay 2014), 2.98 : 1 in Yeniçağa Lake (Kılıç and Becer 2017), 1.5 : 1 in the River Inny (Caffrey *et al.* 2008). Although the sex ratio in most of the species was close to 1, this may vary from species to species, differing from one population to

another of the same species, and may vary year after year within the same population. At early life stages the ratio of males is higher, but at later stages the female ratio is higher (Nikolsky 1963) and the results are in agreement with the findings of (Koç *et al.* 2006; Kaptan 2014; Özay 2014; Kılıç and Becer 2017). Some of the research found that the number of female is higher than males in all age groups (Ünver and Erk'akan 2012). Most of the samples studied in the present study belonged to the III year age group. Koç *et al.* (2006); Ünver and Erk'akan (2012); Özay (2014) reported a similar situation for İzkizcetepeler Dam Lake, Tödürge Lake and the Akçay Stream populations. Majority of the specimens were in the II year age group for the Devres Creek and Istranca Stream (Balık *et al.* 2004; Kaptan 2014). The number of the individuals was in the age group III in this study.

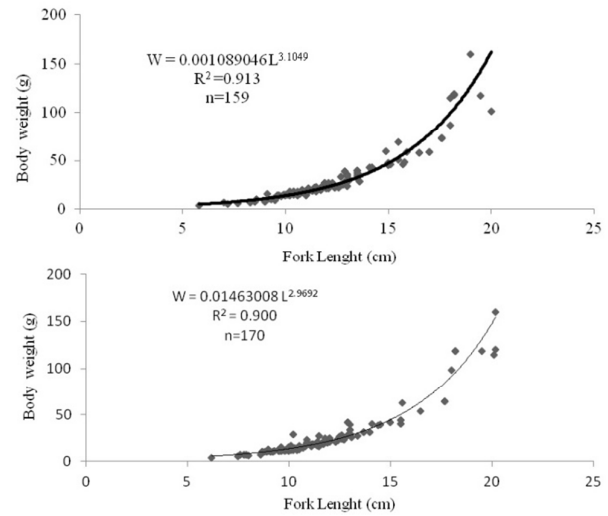


FIGURE 3 Length-weight relationships in female (above) and male (below) *Squalius cephalus*

The males were longer than the females in all the age groups in this research. The females of III, IV, V and VI year age groups were found heavier than the males, while in other age groups, the males were found heavier than the females. The males were longer and heavier at earlier life stages, while the females were longer and heavier at later stages (Koç *et al.* 2006; Ünver and Erk'akan 2012, Özay 2014). Kaptan (2014) found that females were heavier than males in all ages according to this study. Variations in fish growth in terms of length and weight can be explained as an adaptive response to different ecological conditions (Nikolsky 1963). The von Bertalanffy growth equations were: $L_t = 27.163 [1 - e^{-0.159(t+1.47)}]$ for females and $L_t = 27.078 [1 - e^{-0.160(t+1.46)}]$ for males; $W_t = 286.14 [1 - e^{-0.159(t+1.47)}]^{3.1049}$ for females and $W_t = 284.43 [1 - e^{-0.160(t+1.46)}]^{2.9692}$ for males.

Male individuals were longer than females at I, II, IV and VI, while females were longer than males at III and V. When weights were examined, it was determined that male individual at I and II ages were heavier than female individual while females were heavier than males at other ages (Table 2). While some earlier studies have reported similar theoretical maximum length (Koç *et al.* 2006), other studies were different (Bulut *et al.* 2012; Sedaghat *et al.* 2012; Özay 2014; Kaptan 2014). This variation may be due to different stages in ontogenetic development, as well as differences in condition, length, age, sex and gonadal development of fish (Ricker 1975). Geographic location and some environmental conditions such as temperature, organic matter, and quality of food, time of capture, stomach fullness, disease, parasitic loads (Bagenal and Tesch 1978) affect growth.

al. 2012; Özay 2014; Kaptan 2014). This variation may be due to different stages in ontogenetic development, as well as differences in condition, length, age, sex and gonadal development of fish (Ricker 1975). Geographic location and some environmental conditions such as temperature, organic matter, and quality of food, time of capture, stomach fullness, disease, parasitic loads (Bagenal and Tesch 1978) affect growth.

TABLE 2 Length–weight relationship (*a* and *b*), growth (L_{∞} , *K*, t_0).

Study area	Weight range	Length range	N	a	b	r ²	L _∞	k	t ₀	Ref.
İkizce tepeler	18.6-243.6 ^a	11.1-24.8 ^a	172 ^a	0.0227 ^a	2.87 ^a	0.90 ^a	26.7 ^a	0.26 ^a	-1.55 ^a	Koç <i>et al.</i> (2006)
Dam Lake	29.3-173.9 ^b	12.2-24.1 ^b	242 ^b	0.0194 ^b	2.92 ^b	0.89 ^b	28.9 ^b	0.22 ^b	-1.55 ^b	
Maritza River	41-290	-	161	0.015	3.06	0.99	48.8	0.15	-0.05	Stefanova <i>et al.</i> (2008)
Assino Creek	-	-	-	-	-	-	63.91	0.123	-0.160	Pompei <i>et al.</i> (2011)
Gamasiab River	31.4-271.12	13.82-29.51	60	0.006	3.97	0.97				Sedaghat <i>et al.</i> (2012)
Tödürge Lake	3.8-120.5 ^a	6.6-20.1 ^a	93 ^a	0.012 ^a	3.03 ^a					Ünver and Erk'akan (2012)
	1.5-320.8 ^b	5.3-27.9 ^b	373 ^b	0.010 ^b	3.10 ^b					
Akçay Stream	3.78-73.52 ^a	6.8-18.2 ^a	168 ^a	0.078 ^a	3.16 ^a	0.97 ^a	26.09 ^a	0.281 ^a	-0.393 ^a	Özay (2014)
	2.76-124.6 ^b	6.7-24.6 ^b	145 ^b	0.0116 ^b	2.97 ^b	0.96 ^b	36.27 ^b	0.102 ^b	-1.372 ^b	
Istranca Stream	0.70-132.50 ^a	3.9-23 ^a	488 ^a	0.0093 ^a	3.08 ^a	0.99 ^a	39.51 ^a	0.137 ^a	-0.682 ^a	Kaptan
	0.23-357.50 ^b	3.2-30.1 ^b	171 ^b	0.0071 ^b	3.18 ^b	0.99 ^b	49.13 ^b	0.127 ^b	-0.488 ^b	(2014)
Yeniçağa Lake	-	-	729	-	-	-	36.88	0.248	-1.278	Kılıç and Becer (2017)
Devres Stream	4.0-164 ^a	5.9-20.2 ^a	159 ^a	0.0146 ^a	2.97 ^a	0.90 ^a	27.1 ^a	0.160 ^a	-1.46 ^a	Present study
	4.2-168 ^b	5.6-20.1 ^b	170 ^b	0.0108 ^b	3.11 ^b	0.91 ^b	27.1 ^b	0.159 ^b	-1.47 ^b	

^a male, ^b female; N, number of fish, W (g), L (cm).

Condition factor of chub varied from 1.01 to 2.75 in male; from 1.04 to 2.35 in female. Maximum CF was found as 2.75. The results are in agreement with some earlier reports (Koç *et al.* 2006), while it differs from the studies carried out by (Balık *et al.* 2004; Bostancı and Polat 2009; Ünver and Erk'akan 2012). CF of *S. cephalus* differed in terms of age and gender of fish (Table 1). CF values of *S. cephalus* in the Devres Stream was recorded to be lower than 3.

The slope (*b*) values of the length–weight relationship in both gender was found as a 3.049. Similar *b* values for *S. cephalus* were reported earlier (Bostancı and Polat 2009; Ünver and Erk'akan 2012, Bulut *et al.* 2012), but it differed from those found several studies (e.g. Koç *et al.* 2006; Sedaghat *et al.* 2012; Özay 2014; Kaptan 2014).

The *b* value is often 3.0 and generally between 2.5 and 3.5. As the fish grows, changes in weight are relatively greater than the changes in length, due to approximately cubic relationships between fish length and weight. The *b* values in fish is species specific and varies with sex, age, seasons, physiological conditions, growth increment and nutritional status of fish (Ricker 1975; Bagenal and Tesch 1978).

In conclusion, this is the study presenting the age composition, sex ratio, length and weight growth, the length–weight relationship, and the condition factor of *S. cephalus* in the Devres Stream, Kızılırmak River. In addition, it is recommended that the necessary steps should be taken as soon as possible to protect the *S. cephalus* population in the Devres Stream, Kızılırmak River after investigating its stock situation, breeding and feeding behaviors.

ACKNOWLEDGEMENTS

The author would like to thank the anonymous reviewers for their valuable comments and suggestions to improve the quality of the paper. This study has been accepted for presentation at International Symposium on Fisheries and Aquatic Sciences in 2016 (FABA 2016, Antalya, Turkey).

REFERENCES

- Altındag A (1996) Some population characteristics, growth and condition of chub (*Leuciscus cephalus*, Linne 1758) in Akşehir Lake. Turkish Journal of Zoology 20: 53–65.
- Arlinghaus R and Wolter C (2003) Amplitude of ecological potential: chub *Leuciscus cephalus* (L.) spawning in an artificial lowland canal. Journal of Applied Ichthyology 19(1): 52–54. doi:10.1046/j.1439-0426.2003.00343.x

- Bagenal TB and Tesch FW (1978) Age and growth. In: Methods for assessment of fish production in fresh waters. IBP Handbook No. 3. Bagenal T (Ed). Blackwell Scientific Publications, Oxford, pp. 101–136.
- Balık S, Sarı HM, Ustaoglu MR and Ilhan A (2004) Age and growth characteristics of chub (*Leuciscus cephalus* L., 1758) population in Işıkli Lake, Çivril, Denizli, Turkey. Ege University Journal of Fisheries and Aquatic Science 21: 257–262.
- Bostancı D and Polat N (2009) Age determination and some population characteristics of chub (*Squalius cephalus* L., 1758) in the Çamlidere Dam Lake (Ankara, Turkey). Turkish Journal of Science & Technology 4(1): 25–30.
- Bulut S, Mert R, Konuk M, Algan B, Alaş A and Solak K (2012) The Variation of Several Biological Characteristics of the Chub, *Squalius cephalus* (L., 1758), in the Örenler Dam Lake, Northwest Anatolia, Turkey, Notulae Scientia Biologicae 4(3): 27–32.
- Caffrey JM, Acevedo S, Gallagher K and Britton R (2008) Chub (*Leuciscus cephalus*): a new potentially invasive fish species in Ireland. Aquatic Invasions 3(2): 201–209.
- Çiçek E, Birecikligil SS and Fricke R (2016) Addenda and errata of: Freshwater fishes of Turkey: a revised and updated annotated checklist. FishTaxa 1(2): 116–117.
- Dirican S, Haldun M and Çilek S (2012) Condition factor of some cyprinid fishes of Kiliçkaya Reservoir, Sývas, Turkey. Indian Journal of Animal Research 46 (2): 172–175.
- Geldiay R and Balık S (1999) Freshwater fishes of Turkey. Ege University Faculty of Sciences Publication No: 46, İzmir, pp. 182–184 (in Turkish).
- Habasby AP (1974) Age, growth, spawning and some biochemical data in the Chub (*Leuciscus cephalus* L.) in the Rouchovanka Creek. Zoologické Listy 13: 71–83.
- Hanel L (1982) Note on the length growth of the chub (*Leuciscus cephalus*, Pisces, Cyprinidae) in the reservoir Klíčava and the River Berounka (in Czech). Věstník Československé Společnosti Zoologické 46: 241–256.
- Hanel L (1984) Notes of age and growth of the chub (*Leuciscus cephalus*), dace (*L. leuciscus*) and orfe (*L. idus*) (Pisces, Cyprinidae) in the rivulet Bystřice (northeastern Bohemia) (in Czech). Věstník Československé Společnosti Zoologické 35: 241–250.
- İnnal D (2010) Population Structures and Some Growth Properties of Three Cyprinid Species [*Squalius cephalus* (Linnaeus, 1758); *Tinca tinca* (Linnaeus, 1758) and *Alburnus escherichii Steindachner*, 1897] Living in Camkoru Pond (Ankara-Turkey). Kafkas University Journal of the Faculty of Veterinary Medicine, 6 (Suppl-B): 297–304.
- Kaptan Ç (2014) Growth, feeding and reproduction biology of *Squalius cephalus* (Linnaeus, 1758) in the Istanca stream. İstanbul University, Msc Thesis. 115 pp.
- Kara C and Solak K (2004) Growth properties of chub (*Leuciscus cephalus* L., 1758) in Sir Dam Lake (Kahramanmaraş). KSU Sciences and Engineering Journal 7(2): 1–8.
- Karataş M and Can MF (2005) Growth, mortality and yield of chub (*Leuciscus cephalus* L., 1758) population in Almus Dam Lake, Turkey. Journal of Biological Sciences 5(6): 729–733.
- Kırankaya ŞG and Ekmekçi FG (2007) Variations in growth properties of chub (*Squalius cephalus*, L., 1758) living in Gelingüllü Dam Lake. Journal of Balıkesir University Institute of Science and Technology 9(2): 125–134.
- Kiliç S and Becer ZA (2017) Growth and Reproduction of Chub (*Squalius cephalus*) in Lake Yeniçağa, Bolu, Turkey. International Journal of Agriculture & Biology. DOI: 10.17957/IJAB/15.0106.
- Koç HT, Erdoğan Z, Tinkci M and Treer T (2006) Age, growth and reproductive characteristics of chub, *Leuciscus cephalus* (L., 1758) in the İkizcetepeler Dam Lake Balıkesir, Turkey. Journal of Applied Ichthyology 23(1): 1–6.
- Lagler KF (1966) Freshwater fishery biology. W. M. C. Brown Company, Dubuque, IA. 421.
- Le Cren ED (1951) The length-weight relationship and seasonal cycle in gonad weight and condition in Perch, *Perca fluviatilis*. Journal of Animal Ecology 20: 201–219.
- Lelek A (1959) Poznamky o stari a pomneru pohlavi u jelce tlouste, *Leuciscus cephalus* (L.) v rece Rokythe. Zool. listy, 8: pp. 1 (Cz).
- Leontovyč I (1974) The growth of dace (*Leuciscus leuciscus* (L.)), chub (*L. cephalus* (L.)) and bream (*Abramis brama* (L.)) in the Švihov reservoir in first years after filling (in Czech). Živočišná Výroba / Czech Journal of Animal Science 19: 689–702.
- Leontovyč I (1980) Growth of dace, *Leuciscus leuciscus* (L.), in the Vltava river down the Vltava cascade (in Czech). Živočišná Výroba / Czech Journal of Animal Science 25: 825–834.
- Nikolsky GV (1963) The ecology of fishes (translated by L. Birkett). Academic Press, London, 352 pp.
- Özay GG (2014) Investigation of bio-ecological characteristics of chub (*Squalius cephalus* L.1758) in Akçay (Muğla-Denizli). Muğla Sıtkı Koçman University, Msc Thesis. 115 pp.
- Pompei L, Carosi A, Pedicillo G, Rocchini E and Lorenzoni M (2011) Age and growth analysis of the chub, *Squalius squalus* (Bonaparte, 1837), in the Assino Creek (Umbria, Italy). Knowledge and Management of Aquatic Ecosystems 400, 09.

- Raikova-Petrova G, Hamwi N and Petrov I (2012) Spawning, sex ratio and relationship between fecundity, length, weight and age of chub (*Squalius cephalus* L., 1758) in the Middle Stream of Iskar River (Bulgaria). *Acta Zoologica Bulgarica* 64: 191–197.
- Ricker WE (1975) Computation and interpretation of biological statistics of fish populations. *Journal of the Fisheries Research Board of Canada* 191, 382 pp.
- Sedaghat S, Ahangari WDP, Arabi MH, Rahmani H and Vatandoost S (2012) Age and Growth of Chub, *Squalius cephalus* (Bonaparte, 1837), in Gamasiab River of the Hamadan Province, Iran. *World Journal of Fish and Marine Sciences* 4(6): 550–553.
- Sparre P and Venema SC (1992) Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Technical Paper n 306. (Rev. 1). FAO, Rome, 376 pp.
- Stefanova E, Uzunova E, Hubenova T, Vasileva P, Terziyski D and Iliev I (2008) Age and growth of the chub, *Leuciscus cephalus* L. from the Maritza River (South Bulgaria). *Bulgarian Journal of Agricultural Science* 14: 214–220.
- Švátora M and Pivnička K (1986) The growth of the weed fishes in the Želivka river and reservoir in 1970–1985 (in Czech). *Živočišná Výroba / Czech Journal of Animal Science* 31: 911–920.
- Švátora M, Pivnička K (1989) The growth of nine fish species in the Prague section of the Vltava river (in Czech). *Živočišná Výroba / Czech Journal of Animal Science* 34(10): 939–948.
- Şaşı H and Balık S (2003) Age, growth and sex ratio of chub (*Leuciscus cephalus* L., 1758) in Topçam Dam Lake. *Ege University Journal of Fisheries and Aquatic Science* 20: 503–515.
- Şen F and Saygın F (2008) Biological Properties of Chub (*Leuciscus cephalus* L., 1758) in Karasu Stream (Muş/Turkey). *Journal of Animal and Veterinary Advances* 7(8): 1034–1037.
- Türkmen M, Haliloğlu İH, Erdoğan O and 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.
- Ünver B (1998) An investigation on the reproduction properties of chub (*Leuciscus cephalus* (L., 1758) in Lake Tödürge (Zara/Sivas). *Turkish Journal of Zoology* 22: 141–147.
- Ünver B and Erk'akan F (2012) Population characteristics of *Squalius cephalus* in Lake Tödürge (Sivas). *Ege Journal of Fish Aquatic Science* 29: 95–100.
- Vlach P and Švátora M (2000) Growth of dace and chub in the conditions of small streams in the Landscape Protected Area Křivoklátsko. In: Mikešová J. (ed.): Proceedings of the 4th Czech Conference of Ichthyology, Brno. pp. 80–85.
- Vostradovský J (1961) Contribution to the biology and growth of the carp, perch and dace in the new water valley reservoir of Lipno (in Czech). *Živočišná Výroba / Czech Journal of Animal Science* 6: 287–294.

CONTRIBUTION OF THE AUTHORS

SB & AG primary data collection;
SB data processing, manuscript preparation