ACTA ZOOLOGICA BULGARICA

Aquatic Ecology
Research Article

Acta Zool. Bulg., 75 (2), June 2023: 243-249

Published online 28 June 2023
https://www.acta-zoologica-bulgarica.eu/2023/002662

Growth of the Skadar Chub *Squalius platyceps* Župančić et al., 2010 (Actinopterygii: Cyprinidae): A Comparative Study of the Populations in the Brestica Stream and the Upper Zeta River, Montenegro

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Abstract: The structure and growth of the autochthonous population of *Squalius platyceps* in the Brestica Stream and the allochthonous population of the same species in the Upper Zeta River were studied based on the examination of 232 specimens. The mean length was 15.7 ± 5 cm in the Brestica Stream and 18.1 ± 3.8 cm in the Upper Zeta River. The mean weight was 59.8 ± 44.1 g in the Upper Zeta River and 61.7 ± 55.6 g in the Brestica Stream. Juveniles (64 %) and the 3^+-year age group (38 %) dominated the autochthonous population. The 2^+-year age group (43 %) and juveniles (48.5 %) prevailed in the allochthonous population. The growth rate (*a*) was 0.22 in the Upper Zeta River and 0.33 in the Brestica Stream. Mean back calculated total lengths was from 6.3 ± 1.6 cm to 17.1 ± 3.2 cm in the Brestica Stream. In the Upper Zeta River, the mean back calculated total lengths ranged from 7.5 ± 1.6 cm to 22.2 ± 5.6 cm. The study contributes to ecological characterisation of *S. platyceps* in previously unstudied habitats and provides baseline data needed for the population management.

Key words: chub population, structure and growth, Zeta River, endemic cyprinids

Introduction

The Skadar chub *Squalius platyceps* Župančić, Marić, Naseka & Bogutskaya, 2010 (Cyprinidae: Leuciscinae) occurs in inland waters of Albania, Montenegro and North Macedonia (Freyhof 2011). It is the most translocated fish species in Montenegro, being introduced to artificial lakes and small ponds as well as to other river basins such as the Piva River (Marić 2019). One of the main reasons for assessing fish age is to explain its growth rate, which represents the dynamics of the length or weight during a certain period. Since the early 1900s, for the majority fish species valued in commercial and recreational fisheries, scales have been used for age and growth assessments (Matta 2018). *Squalius platyceps* from Skadar Lake is a recently-described species (Župančić et al. 2010). Its distribution was precisely determined (Marić & Milošević 2011). It is mainly feeding on vegetation (Marić & Rajković 2004). It is one of the several species of fish used in Montenegrin commercial, sport and recreational freshwater fishing (Marić 2018).

Squalius platyceps is endemic to the Skadar – Drim – Ohrid basin. It has been studied but never from point of view of its growth. Indigenous lake populations of *S. platyceps* have been examined (Krivokapić 2015a, 2015b, 2015c) but little is

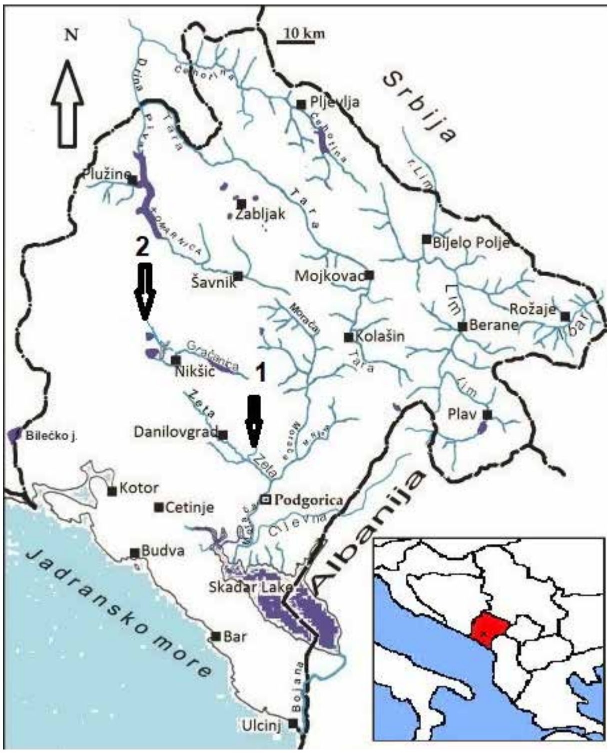

Fig 1. The position of the Zeta River (x) and approximate fish catch locations on the Brestica Stream (1) and the Upper Zeta River (2) marked on the map of Montenegro

known about the biology of its populations in river systems. Furthermore, its acclimatization in non-native habitats is completely unknown. It is unknown whether there are differences and patterns in the growth differing its native and introduced populations. Many studies indicate that such patterns are species-specific, e.g., it has been shown that the abiotic environment plays an important role for the growth of *Carassius auratus* (see Marić 1998).

The main objective of the present study is to compare the growth patterns of *S. platyceps* in its native and non-native habitats, thus providing information of fundamental importance and practical application.

Materials and Methods

Study area

The Zeta River (Fig. 1) belongs to karst hydrography and is the second river in Montenegro in terms of water volume. It has great water stratum swings and is the biggest sinkhole river in Montenegro. The valley of the Zeta River is characterised by paleogenic and quaternary sediments (clay and sandy) (Radojičić 2008). The length of Zeta River with the underground flow is about 89 km; its drainage area is 1547 km² (Marković 1990).

The Upper Zeta River from Nikšić Field disappears into the subsurface and reappears approximately 5 km southeast in Bjelopavlići Plain to form the Lower Zeta River. The water follows a trajectory with an altitude difference of 550 m during its subsurface flow, which gives an important hydroelectric potential (Frankl et al. 2016). The Brestica Stream is a tributary of Lower Zeta and its area is characterised by layered and banked limestones with radiolites, hippurites and red marly limestones (Vujačić et al. 2017). The mean temperature of the Zeta River from November to May was 10.8°C. From June to October, the mean temperature was 17.8°C. The pH value ranged from 7.57 to 8.05 and the partial pressure of carbon dioxide ranged from $10^{-2.8}$ to $10^{-2.4}$ atm (Živković et al. 2020). Water bodies belonging to the Lower Zeta River are characterised to belong from good up to excellent water quality class. On the other hand, the Upper Zeta River belongs to the poor and good water quality classes (Doderović et al. 2020). Anthropogenic sources leading to pollution of the Upper Zeta River include weighty metal disposal in insufficiently defended landfills, waste disposal, organic and inorganic fertilisers, trash mud and coal burning leftovers (Marić & Stanić 2021).

Data sampling and processing

Data from 232 specimens of Skadar chub (*S. platyceps*) were studied. The specimens were caught from two sites located in the upper part of the Zeta River (42°30'19.3" N, 19°13'11.3" E) during June (spawning period) and one from the Brestica Stream (42°48'39.2" N, 18°55'31.1" E) (Fig. 1) during April (the end of the pre-spawning period) 2015. Specimens were caught by electroshocking with 200–300 V, 40-Hertz frequencies and one anode. The river area where specimens were captured is about 150 m long and 5–15 m wide, with a depth of 30–100 cm. The collected material was analysed on site or immediately frozen (89 specimens were returned to the river and 143 were sacrificed).

The total length (cm) of every fish was estimated from the tip of the snout (mouth closed) to the extended end of the caudal fin using a measuring board (± 0.1 mm). The body weight was noted to the closest gram using an electronic balance (± 0.1 g). A light microscope was used to count annual rings of scales for age determination. The Keyence electronic microscope was used to measure the distance between annual rings for growth calculations. The specimens were divided into 46 length groups with a range of 5 mm each to estimate the age groups. The first group was 5.1–5.5 cm and the last group was 27.6–28 cm. In addition, the specimens were divided into weight classes with a range of 20 g each starting from the first group (up to 20 g) and ending in the last group (261–280 g).

The estimation of the length growth was calculated using the formula of Dahl Lea (1910):

$$li = \frac{Si}{S * l}$$

where l is the length of the body, S is the length of the scales and li and Si are the values in a given year.

The length age ratio is given by Von Bertalanffy's equation (von Bertalanffy 1934, 1938):

$$Y = A - Be^{-eX}$$

where A is an asymptote, B is the section with ordinate, e is the current growth rate and X is the unit of time.

A calculation of differences between individual groups (females and males) was estimated by a student t test according to the following formula:

$$t = \frac{M1 - M2}{\sqrt{SM1^2 + SM2^2}}$$

where M_1, M_2 are mean values and SM_1, SM_2 are the corresponding errors of the mean value (Mayrat 1970). The absolute and relative growths were estimated to characterise a growth rate better.

The coefficient of determination (R^2) was used as an indicator of the quality of the regression (Scherrer 1984). All the statistical analyses were considered at a significance level of 5% or 1% ($P < 0.05$ or $P < 0.01$).

Abbreviations: a.g. – age groups, SD – standard deviation, SE – standard error, SL – standard length, TL – total length, TL(M) – mean value of total length, TL_1, TL_2, TL_3, TL_4 – mean values of total lengths by age groups, VBGF – Von Bertalanffy's growth function, W – weight, W(M) – mean weight, *S*. – *Squalius*.

Results

The sample from the Brestica Stream consisted of 46 males (31 %), 7 females (5 %) and 95 juveniles (64 %). Based on the analysis of the χ2 test, there was a statistically significant difference in sex representation concerning the theoretically expected ratio (1:1) ($\chi2 = 28.7$, d.f. = 1, $p < 0.01$). The Upper Zeta River's sample consisted of 26 males (29 %), 20 females (22.5 %) and 43 juveniles (48.5 %). Based on the analysis of the χ2 test, there was not a statistically significant difference in the sex representation concerning the theoretically expected ratio (1:1) ($\chi2 = 0.78$, d.f. = 1, $p < 0.01$).

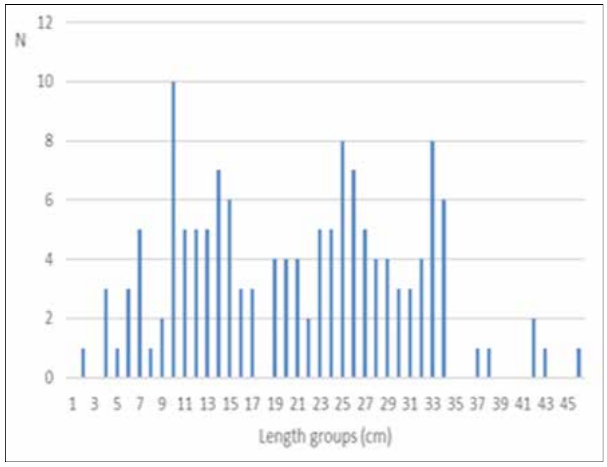

Fig. 2. TL distribution of 143 specimens of *Squalius platyceps* in the Brestica Stream (2015)

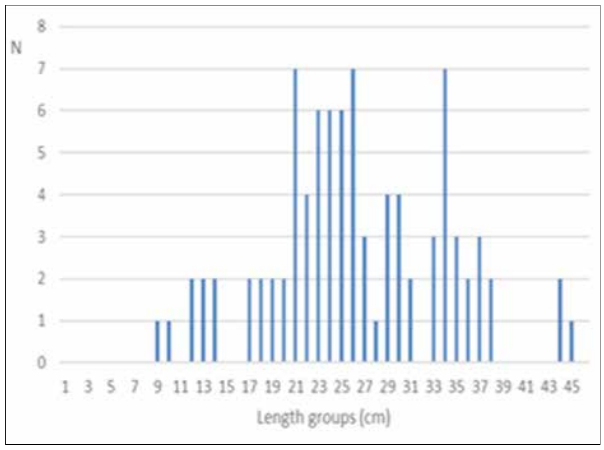

Fig. 3. TL distribution of 89 specimens of *Squalius platyceps* in the Upper Zeta River (2015)

The total length of the specimens from the Brestica Stream ranged from 6.6 cm to 27.8 cm, with a mean length of 15.7 ± 5 cm (mean length ± SD). The length class of 9.6–10 cm contained the most significant number of specimens (10) (Fig. 2).

In the Upper Zeta River, the total length of the specimens ranged from 9.5 cm to 27 cm (mean length 18.1 ± 3.8 cm). The three length classes of 14.6–15 cm, 17.6–18 cm and 21.6–22 cm contained the most significant number of specimens (7) (Fig. 3).

The weight of the specimens from the Brestica Stream ranged from 2.9 g to 262 g, with a mean weight of 61.7 ± 55.6 g (mean weight ± SD). The weight class of 0–20 g contained the most significant number of specimens (52) (Fig. 4).

In the Upper Zeta River, the weight of the specimens ranged 5–230 g, with a mean weight of 59.8

± 44.1 g. The weight class of 20–40 g contained the most significant number of specimens (28) (Fig. 5).

In the Brestica Stream, the 3^+ y age group contained the most significant number of specimens (52). On the other hand, the 2^+ y age group contained the most significant number of specimens (38) in the Upper Zeta River (Table 1).

There was a relatively high statistical significance ($R^2 = 0.79$) between the total length and age correlation for the population in Stream Brestica. This suggests that Von Bertalanffy's model is a reasonable representation of the growth trajectory of the *S. platyceps* population under study. However, it is important to note that the remaining 21% of

Table 1. Age structures of 232 specimens of *Squalius platiceps* from the Brestica Stream and the Upper Zeta River (2015)

Sites	Age group	N	%	W variation (g)	W(M) ± SD	TL variation (cm)	TL(M) ± SD
Stream Brestica	1^+	36	25	2.9 - 17.1	10.7 ± 5.1	6.6 - 11.7	9.9 ± 1.7
	2^+	51	36	8.1 - 89.3	44 ± 21.8	9.4 - 19.2	15.1 ± 2.3
	3^+	54	38	51.4 - 254	106.7 ± 40.1	16.3 - 29	20.2 ± 2.3
	4^+	2	1	52.7 - 262	152.1 ± 70.6	17.00 - 27.8	22.4 ± 3.6
Upper Zeta River	1^+	16	18	5 - 54	22.4 ± 17.1	9.5 - 17	13.1 ± 2.4
	2^+	38	43	20 - 120	41.7 ± 24.1	14 - 23.5	16.9 ± 1.7
	3^+	28	31	30 - 230	86.9 ± 32.6	17.5 - 27.5	21.1 ± 2.1
	4^+	7	8	90 - 215	135 ± 122.7	22.5 - 27	24.1 ± 2.1

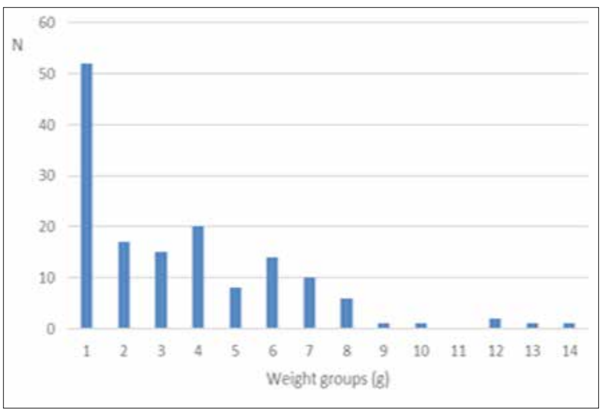

Fig. 4. W distribution of 143 *Squalius platyceps* specimens in the Brestica Stream (2015)

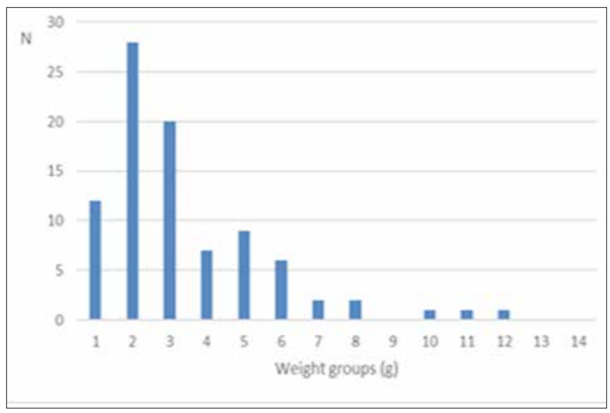

Fig. 5. W distribution of 89 *Squalius platyceps* specimens in the Upper Zeta River (2015)

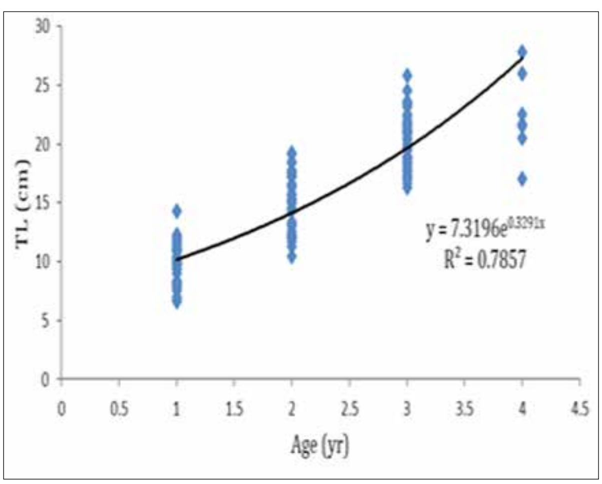

Fig. 6. VBGF of 143 *Squalius platyceps* specimens in the Brestica Stream (2015)

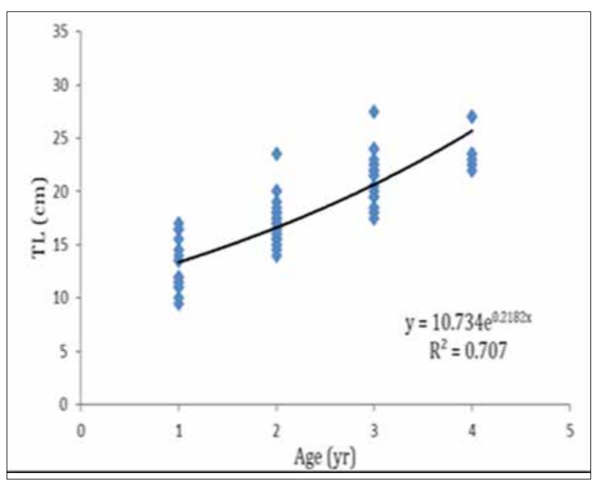

Fig. 7. VBGF of 89 *Squalius platyceps* specimens in the Upper Zeta River (2015)

Table 2. Back calculated total lengths of 143 specimens of *Squalius platyceps* from the Brestica Stream (2012–2015)

Markers in the catching time				Age and average values for TL (cm)			
Generation	Age group	(M) TL (cm)	N	TL_1	TL_2	TL_3	TL_4
2012	4^+	22.4 ± 3.6	7	5.5 ± 0.9	11.8 ± 3.0	17.1 ± 3.2	-
2013	3^+	20.2 ± 2.7	49	6.3 ± 1.7	12.1 ± 2.3		
2014	2^+	15.1 ± 2.3	40	6.5 ± 1.7			
2015	1^+	9.9	45				
Average values (M)				6.3 ± 1.6	12.1 ± 2.3	17.1 ± 3.2	
Absolute growth (cm)				5.9	5.1	3.6	
Relative growth (%)				42.9	27.4	16.2	

Table 3. Back calculated total lengths of 89 specimens of *Squalius platyceps* in the Upper Zeta River (2012–2015)

Markers in the catching time				Age and average values for TL (cm)			
Generation	Age group	(M) TL (cm)	N	TL_1	TL_2	TL_3	TL_4
2012	4^+	24.1 ± 2.1	7	8.2 ± 2.0	14 ± 2.1	19.2 ± 2.4	22.21 ± 5.6
2013	3^+	21.1 ± 2.1	28	7.5 ± 1.1	13.4 ± 1.7	18.2 ± 1.8	
2014	2^+	16.9 ± 1.7	37	7.2 ± 1.5	12.8 ± 1.6		
2015	1^+	13.1 ± 2.4	16	7.9 ± 2.1			
Average values (M)				7.5 ± 1.6	13.2 ± 1.7	18.4 ± 2.0	22.2 ± 5.6
Absolute growth (cm)				5.8	5.1	3.6	
Relative growth (%)				42.9	27.4	16.2	

the variation in the data may be due to factors not accounted for in our model, such as environmental factors or individual variation in growth.

The growth rate was a = 0.33 which is presented in Fig. 6. Additionally, the growth is the most intense in the first two years, which could be due to several factors, such as the availability of food, the absence of predators, or favourable environmental conditions that facilitate breeding and survival.

In the Upper Zeta River, there was a moderate statistical significance (R^2 = 0.71) between the total length and age correlation. While Von Bertalanffy's model provides a reasonable approximation of the growth trajectory of the *S. platyceps* population, it is important to note that there may be other factors that contribute to the observed variation in the data, such as predation pressure or environmental conditions. The growth rate was a = 0.22 which is presented in Fig. 7.

Mean back calculated lengths in the first year ranged from 6.3 ± 1.6 cm for the population in the Brestica Stream (Table 2) to 7.5 ± 1.6 cm in the Upper Zeta River (Table 3). In the second year, mean back calculated lengths ranged from 12.1 ± 2.3 cm for the population in the Brestica Stream to 13.2 ± 1.7 cm in the Upper Zeta River. Mean back calculated lengths ranged from 17.1 ± 3.2 cm in the Brestica Stream to 18.4 ± 2 cm in the Upper Zeta River in the third year.

Discussion

Our study showed no significant difference in sex representation in the population of S. platyceps in the Upper Zeta River, similarly to the results of Raikova-Petrova et al. (2012) for *S. cephalus* from the Iskar River, Bulgaria. However, a statistically significant difference in the population sex structure was found in the Brestica Stream. Thus, our results are only partially consistent with the above-mentioned study. The native *S. platyceps* population had a significantly higher proportion of males than females (6.6 : 1). Males are smaller and reach sexual maturity at a smaller size than females, which results in a length distribution that is skewed towards smaller sizes in Brestica River. Similarly to previous studies (Caffrey et al. 2008, Pompei et al. 2011, Sülün et al. 2014, Kalkan et al. 2002), we showed that males are slightly more numerous than females (1.3 : 1) in the Upper Zeta River.

The method of electrofishing resulted in the determination of age groups and approximate mean values with high precision. It is not known whether the age structure of other fish species from Skadar Lake was precisely determined in this way. Previous studies (Stanković & Trivunac 1981, Marić 2019) have shown that *S. platyceps* in Skadar Lake can grow up to 50 cm and 5.6 kg. We measured a significantly lower maximum length (27.8 cm) and weight (262 g) of *S. platyceps*. Our results on the size are in the agreement with Marić (1998) who has found that *C. auratus* grows significantly faster and achieves higher dimensions in Skadar Lake when compared to many Central and Eastern European localities. In addition, the size of our specimens was significantly lower when compared to the size of chub species from the rivers in the region (Habeković 1994, Delić 1994). Therefore, a proper comparison with previous data is not reasonable.

According to Tedesco et al. (2009), higher water temperatures in river systems lead to faster growth rates and larger maximum sizes in fish populations. In their study, Volkoff & Rønnestad (2020) showed that temperature might affect food digestion and assimilation of fish by increasing digestion and metabolic rates as well as by increasing food intake. Our study showed a faster growth rate and a larger maximum length of the native *S. platyceps* population. This may be a result of a more favourable temperature regime in the Brestica Stream because it is located in a subtropical climate while the Upper Zeta River in a continental climatic area. Additionally, the slower growth of the *S. platyceps* population in the Upper Zeta River could be due to higher pollution levels and, consequently, fewer concentrations of oxygen (Marić & Stanić 2021; see also Pliūraitė et al. 2013).

Our results on the growth rates are in the agreement with previous studies (Copp et al. 2004, Krueger et al. 1994 & Rypel 2014) demonstrating that native fish populations have evolved to be better adapted to the specific environmental conditions of the river system. These adaptations might be associated with the competition, predation and fishing pressures as well as with the genetic differences, which give them a growth advantage over introduced populations. Intensive growth in the first two years of life was also documented in studies on other fish species, e.g., grayling (*Thymallus thymallus*) in the Kupa River (Sprem et al. 2005). In our study, higher growth was shown in the second year than in the first year for the native *S. platyceps* population, which is in agreement with Krivokapić (1998). Slightly larger mean back calculated lengths in the introduced *S. platyceps* population were calculated for 2012–2015, which can be related with the age structure.

Conclusions

The autochthonous population of *S. platyceps* in the Brestica Stream showed a larger maximum length and weight and faster growth than the allochthonous population in the Upper Zeta River. Some of the reasons include lower temperatures and levels of oxygen in the Upper Zeta River and better adaptation of the autochthonous population. Our von Bertalanffy's model had a relatively high and moderate level of fit to the observed data but there was still some unexplained variation. Therefore, further studies in this specific field are required to explain the specific factors, which influence the structure and growth dynamics of *S. platyceps* populations and to refine the accuracy of the model.

Acknowledgements: We acknowledge the assistance from the staff of the Institute for Hydrobiology and Aquatic Systems Management, University of Natural Resources and Life Sciences (BOKU), Austria. We thank the Erasmus+ programme for funding the teaching mobility of Dr Ourania Tzoraki to Montenegro. The EURAXESS Mentoring Programme "Shape the future of a researcher coming to Europe" is highly appreciated. Special thanks to Lana Kljajević, a specialist in English Language and Literature, for proofreading the article.

References

Caffrey J. M., Acevedo S., Gallagher K. & Britton R. 2008. Chub (*Leuciscus cephalus*): a new potentially invasive fish species in Ireland. Aquatic Invasions 3 (2): 201–209.

Copp G. H., Fox, M. G., Przybylski M., Godinho F. N., & Vila I Gispert A. 2004. Life-time growth patterns of Pumpkinseed *Lepomis gibbosus* introduced to Europe, relative to North American populations. © Folia Zoologica: International Journal of Vertebrate Zoology 53 (3): 237-254.

Delić A. 1985. Longitudinal and weight growth of fish in open waters of the Novi Grad municipality. Croatian Journal of Fisheries 40 (4-5-6): 80–85.

Doderović M., Mijanović I., Burić D. & Milenković M. 2020. Assessment of the water quality in the Morača River basin (Montenegro) using a water quality index. Bulletin of the Serbian Geographical Society 100 (2): 67–81.

Frankl A., Lenaerts T., Radusinovic S., Spalevic V. & Nyssen J. 2016. The regional geomorphology of Montenegro mapped using Land Surface Parameters. Zeitschrift für Geomorphologie 60 (1): 1–14.

Freyhof J. 2011. *Squalius platyceps.* IUCN Red List of Threatened Species. e.T188129A8644550. doi:10.2305/IUCN.UK.2011-1.RLTS.T188129A8644550.en. Retrieved 17 March 2023.

Habeković D. 1994. Ichthyofauna of the accumulation lake Prančevići on the river Cetina III. Cyprinidae. Fisheries 52 (3): 25–33.

Kalkan E., Yilmaz M. & Erdeml A. Ü. 2002. Some Biological Properties of the *Leuciscus cephalus* (L., 1758) Population Living in Karakaya Dam Lake in Malatya (Turkey). Turkish Journal of Veterinary & Animal Sciences 29: 49–58.

Krivokapić M. 1998. Growth of *Telestes montenegrinus* from the river Morača, Montenegro (Cyprinidae). Italian Journal of Zoology 65 (suppl.): 241–242.

Krivokapić M. 2015a. Analysis of radial canals and annual and spawning rings in the white chub scales of *Leuciscus* *cephalus albus* (Bonaparte, 1838) (Pisces, Cyprinidae) from Skadar Lake (Montenegro) in the new systematic recognized as *Squalius platyceps*. Journal of Bioscience and Technology 6 (3): 676–685.

Krivokapić M. 2015b. Female reproductive cycle phases (oogenesis) of white chub – *Squalius platyceps* (Actinopterygii, Cyprinidae) from Skadar Lake (Montenegro). International Journal of Biosciences 6 (11): 9–18.

Krivokapić M. 2015c. Male reproductive cycle phases (spermatogenesis) of white chub *Squalius platyceps* (Actinopterygii, Cyprinidae) from Skadar Lake (Montenegro). International Journal of Biosciences 6 (11): 1–8.

Krueger C. C., Perkins D. L., Everett R. J., Schreiner D. R., & May B. 1994. Genetic variation in naturalized rainbow trout (*Oncorhynchus mykiss*) from Minnesota tributaries to Lake Superior. Journal of Great Lakes Research 20(1): 299-316.

Marić D. 1998. Adaptation of introduced silver carp (*Carassius auratus gibelio* Bloch, 1783) in Skadar Lake (Doctoral dissertation). Podgorica, Montenegro: Faculty of Natural Sciences. 268 p.

Marić D. 2018. The Ichthyofauna of Lake Skadar/Shkodra: diversity, economic significance, condition and conservation status. In: PEŠIĆ V., KARAMAN G. & KOSTOANOY A. (Eds.): The Skadar/Shkodra Lake Environment. USA: Springer International Publishing, pp. 363–381.

Marić D. 2019. Freshwater fish fauna (Osteichthyes) of Montenegro. Montenegrin Academia of Science and Art. Special edition. Book 149. 419 p.

Marić D. & Milošević D. 2011. Catalog of the freshwater fish (Osteichthyes) in Montenegro. Podgorica, Montenegro: Montenegrin Academia of Science and Art. 114 p.

Marić D. & Rajković M. 2004. Competitors and predators the cause of crayfish (*Astacus astacus* L.) numerosity decrease in the waters of Nikšić region. Natura Montenegrina 3: 101–111.

Marić D. & Stanić M. 2021. Bioaccumulation of 18 trace metals in muscle and exoskeleton in the noble crayfish (*Astacus astacus* L.) in the river Zeta (Montenegro). Poljoprivreda i Šumarstvo 67 (3): 31–42.

Marković J. Đ. 1990. Encyclopedic geographical lexicon of Yugoslavia. Sarajevo, Bosnia and Herzegovina: Svjetlost. 320 p.

Matta M. E. 2018. Age and Growth of Fishes: Principles and Techniques. Bethesda, Maryland: American Fisheries Society. 359 p.

Pliūraitė V., Virbickas T. & Skrodenytė-Arbačiauskienė V. 2013. Changes in roach (*Rutilus rutilus* (L.)) diet and growth in relation to river water quality. Ekologija 59 (3): 134–141.

Pompei L., Carosi A., Pedicillo G., Rocchini E. & 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.

Radojičić B. 2008. Geography of Montenegro - Natural basis. Podgorica, Montenegro: Duckley Academy of Sciences and Arts. 252 p.

Raikova-Petrova G., Hamwi N. & 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 (2): 191–197.

Rypel A. L. 2014. Do invasive freshwater fish species grow better when they are invasive?. Oikos 123 (3): 279-289.

Stanković M. & Trivunac M. 1981. Food and age of *Leuciscus cephalus albus* in Lake Skadar. In: Karaman S. G. & Beeton M. A. (Eds.): The Biota and Limnology of Lake Skadar. USA, MNE: Institute for Biological and Medical Research in Montenegro & Centre for Great Lakes Studies, pp. 340–342.

Sprem N., Tomljanović T., Piria M., Treer T., Safner R. & Aničić I. 2005. Growth of grayling (*Thymallus thymallus* L.) in Kupa River. Ribarstvo 2: 39–46.

Sülün Ş., Başkurt S., Emiroğlu Ö., Giannetto D., Tarkan A.S., Ağdamar S., Gaygusuz Ö., Tedesco P. A., Sagnes P. & Laroche J. 2009. Variability in the growth rate of chub *Leuciscus cephalus* along a longitudinal river gradient. Journal of Fish Biology 74: 312–319.

Tedesco P. A., Sagnes P. & Laroche J. 2009. Variability in the growth rate of chub *Leuciscus cephalus* along a longitudinal river gradient. Journal of Fish Biology 74: 312–319.

volkoff H., & Rønnestad I. 2020. Effects of temperature on feeding and digestive processes in fish. Temperature 7 (4): 307–320.

Vujačić D., Barović G. & Spalević V. 2017. Physical-geographical Position of the Lower Zeta. In: Pešić V. & Hadžiablahović S. (Eds.): The Book of Abstracts and Programme. MNE: Institute for Biodiversity and Ecology, pp. 195–205.

Živković K. Radulović M., Lojen S. & Pucarević M. 2020. Overview of the chemical and isotopic investigations of the Mareza springs and the Zeta River in Montenegro. Water 12 (4): 957.

Župančić P., Marić D., Naseka A. M. & Bogutskaya N. G. 2010. *Squalius platyceps*, a new species of fish (Actinopterygii: Cyprinidae) from the Skadar Lake basin. Zoosystematica Rossica 19 (1): 154–167.

Received: 01.06.2022
Accepted: 29.03.2023