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Original scientific paper

MORPHOLOGICAL CHARACTERISTICS AND CONDITION OF BLEAK *ALBURNUS ALBURNUS* (TELEOSTEI; CYPRINIDAE) FROM THE BOSNA RIVER

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Abstract. This paper presents data about morphological (morphometric and meristic) characteristics, Fulton's condition factor (K) and length-weight relationship of bleak (*Alburnus alburnus*) from the Bosna River. The fish sampling was performed during December 2016 and the total of 101 bleak individuals was caught. On that occasion, 14 morphometric characteristics, body mass and six meristic characteristics were analyzed. As observed on the basis of morphometric characteristics, the bleak population from the Bosna River was dominated by smaller individuals which could be explained by the period of sampling (winter) and part of river where sampling was performed (coastal shallow part). The obtained values of the Fulton's condition factor indicated that the bleak population from the Bosna River was in a relatively poor condition (0.61), while the parameter *b* indicated a negative allometric growth (b=2.8865) and the fish was characterized by a more intense length growth when compared to the mass growth. The obtained results regarding meristic parameters were mainly similar to the well-known data from the great body of work on the topic.

Key words: bleak, morphometry, meristics, Fulton's condition factor, weight-length relationship.

INTRODUCTION

The freshwater ichthyofauna of Bosnia and Herzegovina (B&H) and the Republic of Srpska (RS) is profoundly rich and diverse. According to Sofradžija (2009), the diversity of freshwater agnathans and fish in B&H counts 118 taxa, among which the most abundant are fish from the Cyprinidae family. One of the cyprinid species of our freshwaters is bleak (*Alburnus alburnus*, Linneus, 1758), which is widespread in the waters of almost all of Europe, including the European part of Russia. In Europe, it is not distributed in the Iberian and Apennine Peninsula, Scotland, Ireland and parts of Sweden and Norway (Bogut *et al.*, 2006), with local introduction into Spain (Vinyoles *et al.*, 2007), and Portugal and Italy (Kottelat and Freyhof, 2007). In B&H, it is a relatively common species in the waters of the Black Sea basin and it is abundant in the middle sections of the rivers Drina, Bosna and other

tributaries of the Sava River. Its population is stable and numerous throughout the area of distribution (Sofradžija, 2009). Bleak inhabits mainly large, slow-flowing waters and lakes (Sofradžija, 2009), where it's often overpopulated (Bogut *et al.*, 2006) but it could be found in rivers of rapid flow and relatively small volume of water (Simonović, 2001). Adults occur in flocks near the surface of the water; larvae live in the riparian zone of rivers and lakes, while juvenile forms leave the coastal region and inhabit pelagic habitats. In winter, large groups reside in armband and other still waters (Kottelat and Freyhof, 2007). They grow up to 160 mm (Kottelat and Freyhof, 2007), or up to 200 mm (Vuković and Ivanović, 1971; Bogut *et al*., 2006; Sofradžija, 2009), and up to 250 mm in extreme cases (Simonović, 2001; Bogut *et al.* 2006). It reaches a mass of 40-50 g (Simonović, 2001) or according to Sofradžija (2009) 50-60 g. The diet consists of plant (various algae) and animal food (zooplankton, larval and adult insects, mostly chironomids, then oligochaetes, nematodes, arachnids, and eggs and small fish). Source of food depends on the age of the individuals and seasonal aspect (Vuković and Ivanović, 1971; Bogut *et al*., 2006; Piria *et al.*, 2006; Piria, 2007). Bleak is listed in the IUCN Red List in the low risk category (LC) (Freyhof and Kotellat, 2008). The species has limited economic and sport-fishing importance and is often used as bait for catching predatory fish (Simonović, 2001).

The reason for the research of this fish species is poor data on its morphology traits, especially for bleak from waters of B&H. Also, during sampling of the ichthyofauna of the Bosna River, it was found that the bleak was a most abundant species. The aim of the study was to describe the morphological variability of bleak from the Bosna River based on morphometric and meristic parameters, to analyze the Fulton's condition factor of individuals and length-weight relationship, whereby these preliminary data can serve as a basis for further research.

MATERIAL AND METHODS

The Bosna River is the largest right tributary of the Sava River in the territory of B&H and belongs to the Sava River Basin (Figure 1). The source of the Bosna River is a strong karst spring located at the foot of the Mount Igman near Sarajevo. The Bosna River flows into the Sava River near Bosanski Šamac. The Bosna River Basin covers an area of 10 460 km^2 or 1/5 of the total area of B&H. It borders with the following catchments: the Vrbas River to the west, the Drina River to the east, the Neretva River to the south and the Sava River to the north. The total length of the Bosna River flow is 275.5 km. The mean elevation of the basin is 640 m a.s.l., the spring is at 491.67 m a.s.l., and the river mouth is at 77.73 m a.s.l (the total height difference is 413.94 m). The hydrographic network of the Bosna River Basin is relatively well developed; significant right tributaries are Miljacka, Stavnja, Krivaja and Spreča, and the left ones are Zujevina, Fojnica, Lašva and Usora. The water regime of the Bosna River is pluvial - snowy with high water in the spring caused by the melting of snow and slightly lower autumn flows as a result of intense rainfall and low summer and winter water flows (AVP Sava, 2018).

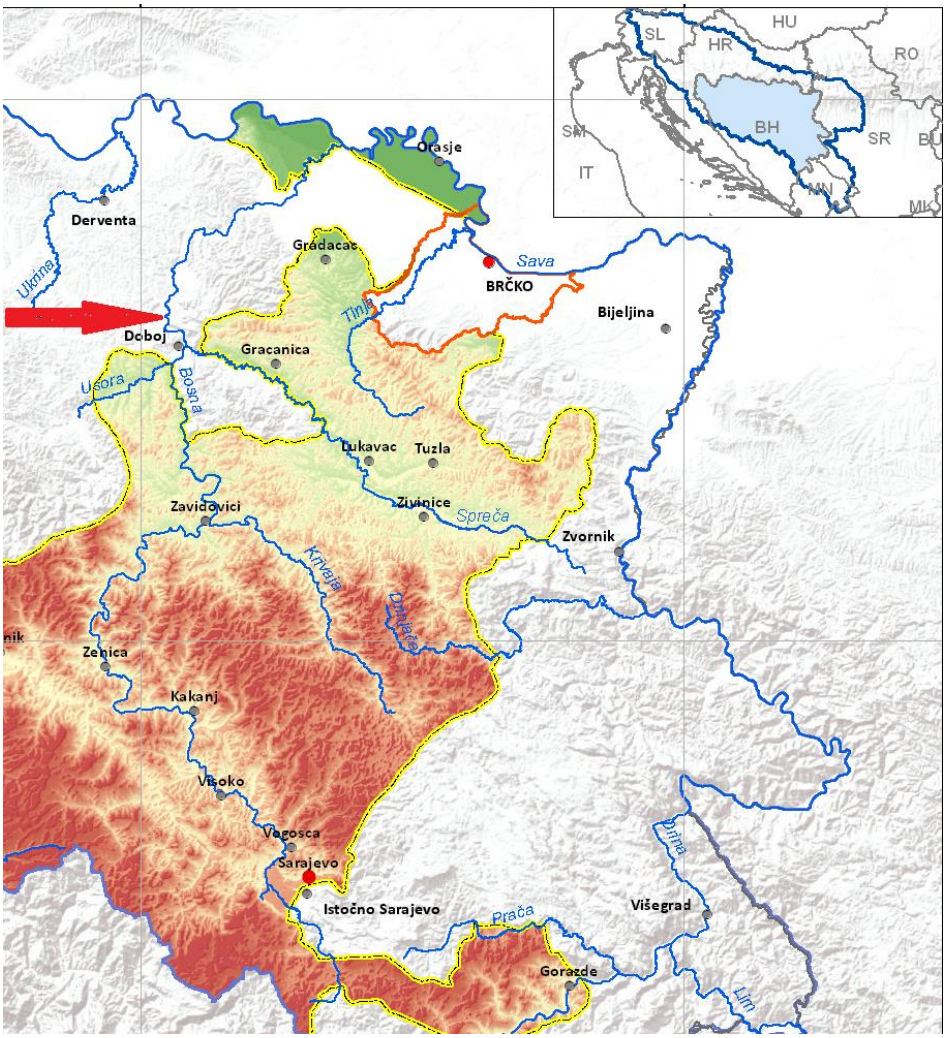

Figure 1. Bosna River Basin (sampling place is marked with red arrow) (AVP Sava, 2016, modified)

Bleak from the Bosna River were sampled by the ELT 62 II GI electrogenerator for fish sampling, 3 kW, during winter period (December, 2016) in the area around Doboj (Figure 1). Sampling was performed on a one-time basis. All fish species collected during the sampling were determined (Vuković and Ivanović, 1971; Kottelat and Freyhof, 2007; Sofradžija, 2009) and counted. Afterwards, the fish were returned to the water unharmed and the sample of bleak was used for morphometric and meristic characteristic analysis. The body mass, 14 morphometric and six meristic characteristics were mesured for each individual. Analyzed morphometric characteristics were (Figure 2): total length (*a*-b_2), standard length (*a*-*v*), antedorsal distance (*c*-*g*), length of dorsal fin base (*g*-*d*), anteventral distance (*m*-*n*), anteanal distance (*o*-*p*), length of anal fin base (*q*-*r*), caudal penducle length (*t*-*v*), maximum body height (H_1-H_2), minimum body height (h_1-h_2), head length (*i*-*l*), preorbital distance (*i*-*j*), horizontal diameter of eye (*j*-*k*) and postorbital distance (*k*-*l*) (according to Vuković and Ivanović, 1977). Measurements were performed using nonius (precision 0.02 mm) and expressed in millimeters (mm), while body mass, expressed in grams (g), was determined by using technical scales of different precision (1 g and 0.01 g). Also, morphometric features

were expressed in percentages of standard body length, except for head length measures which were expressed in percentages of head length.

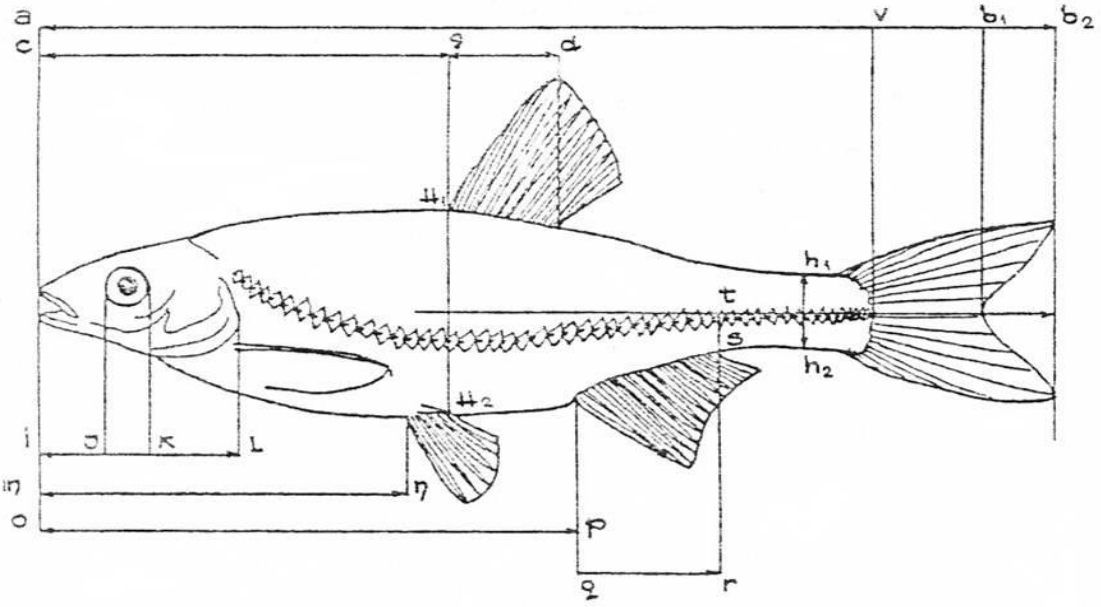

Figure 2. Analised morphometric parameters
(Vuković and Ivanović, 1971)

Condition factors were used to analyze and compare the fitness and nutrition of fish, assuming that heavier fish of a given length were in a better condition (Tesch, as cited in Froese, 2006). Well-fed fish have a Fulton's condition factor (K) value equal to or greater than 1 while malnourished fish have K value less than 1 (Shakir *et al.*, 2010). The Fulton's condition factor was calculated according to the formula $K=100(W/L^3)$ where W is the weight of the fish in grams and L is the total length of the fish in centimeters.

Length-weight relationships were used to assess the extent to which the body mass of a fish corresponded to a given body length (Tesch, as cited in Froese, 2006). As an exponent of the arithmetic form of length-weight relationships, parameter *b* may be equal to 3 (isometric growth type), greater than 3 (positive allometric growth type) and less than 3 (negative allometric growth type) (Froese, 2006; Riedel *et al.*, 2007, Karachle and Stergiou, 2012). The length-weight relationships was determined by the exponential function $W = aL^b$, where W was the mass of fish in grams, L was the total body length in milimeters, *a* was a constant and *b* was an allometry factor (Froese, 2006).

Meristic characteristics included the number of scales in the lateral line, the number of branched and unbranched rays in the dorsal (*PD*), pectoral (PP), ventral (*PV*), anal (*PA*) and caudal (*PC*) fin. These characteristics were determined by counting (macroscopically and using a magnifying glass).

All data were statistically processed using Excel 2007, and the minimum, maximum and mean values and standard deviation were recorded. The results are presented in a descriptive and tabular way.

RESULTS AND DISCUSSION

The analysis of several morphometric and meristic characteristics of bleak from the Bosna River included a total of 101 individuals. On this occasion, 13 other species of fish were found (Table 1), with domination of the Cyprinidae family (12 species), while the Percidae family was represented by one the species. Bleak was the most numerous species with the individual share in the total catch of 38%.

Table 1. Qualitative and quantitative composition of fish of the Bosna River in the area surrounding the city of Doboj

No	Latin name (family)	Local name	No ind.	%
1	*Rhodeus amarus* (Cyprinidae)	Gavčica	29	10.9
2	*Gobio obtusirostris* (Cyprinidae)	Krkuša	2	0.8
3	*Pseudorasbora parva* (Cyprinidae)	Bezribica	1	0.4
4	*Romanogobio uranoscopus* (Cyprinidae)	Tankorepa krkuša	5	1.9
5	*Barbus balcanicus* (Cyprinidae)	Potočna mrena	4	1.5
6	*Carassius gibelio* (Cyprinidae)	Babuška	12	4.5
7	*Alburnoides bipunctatus* (Cyprinidae)	Dvoprugasta uklija	23	8.6
8	*Alburnus alburnus* (Cyprinidae)	Uklija	101	38.0
9	*Chondrostoma nasus* (Cyprinidae)	Škobalj	24	8.9
10	*Leucaspius delineatus* (Cyprinidae)	Bjelica	2	0.8
11	*Squalius cephalus* (Cyprinidae)	Klen	51	19.2
12	*Vimba vimba* (Cyprinidae)	Nosara	8	3.0
13	*Perca fluviatilis* (Percidae)	Grgeč	4	1.5
	Total		**266**	**100**

Morphometric characteristics

The values for the 14 analyzed morphometric characteristics and body mass are provided for absolute values (Table 2) and relative values, expressed in % (Table 3).

Table 2. Absolute values of morphometric characteristics of bleak (n- number of individuals; Min- minimum value; Max- maximum value; AV-average value; SD- standard deviation). All morphometric values are expressed in millimeters except for the body mass expressed in grams. The meanings of abbreviations for morphometric characteristics can be found in the Material and Methods section.

Morphometric parameters	N=101			
	Min	Max	AV	SD
a – b_2	40.10	120.20	81.63	20.18
a – v	33.50	91.20	65.99	15.94
c – g	18.10	80.00	37.68	9.99
g – d	3.00	10.50	6.65	1.81
m – n	15.60	46.70	30.35	7.24
o – p	22.80	62.30	42.99	10.32
q – r	4.20	20.90	13.15	3.73
t – v	5.00	20.10	12.12	3.13

$H_1 – H_2$	5.00	20.10	12.42	3.74
$h_1 – h_2$	2.10	8.90	5.30	1.59
i – l	7.90	22.90	16.20	3.87
i – j	1.80	5.90	3.72	1.10
j – k	2.00	6.50	4.46	1.02
k – l	3.80	13.10	7.95	2.18
Body mass	0.46	11.17	3.89	2.57

A research conducted by Gamma and Niberg (2017) on bleak of Finnish waters (N=66) indicated that the total body length ranged from 69.50 mm to 157.70 mm, and the body mass ranged from 2.20 g to 23.00 g. For bleak from the Timiş River (Romania) (N=71), the standard body length ranged from 23.00 mm to 82.00 mm and the body mass from 0.08 g to 10.11 g (Stavrescu-Bedivan *et al.*, 2017). Data on mean values for the length and weight of bleak from Koviljsko-Petrovaradin rit (N=100) were given by Lujić *et al.* (2013), with the total body length of 102.83 mm, the standard body length of 84.16 mm and the body weight of 6.51 g. Data for mean values of the body length and mass were also available for bleak from the artificial reservoir of Zhrebchevo (Bulgaria) (N=27) where the total body length was 156.60 mm, the standard body length was 131.00 mm, and the average body weight was 32.63 g (Georgiev *et al.*, 2015). The same authors provided data for the mean values of some other morphometric parameters, including head length (25.70 mm) and maximum body height (34.80 mm). Piria (2007) provided data for basic morphometric characteristics for bleak from two sites of the Sava River: at the Medsave site (N=148) the standard length of the body ranged from 43.00 mm to 131.00 mm, the mean value of the total body length was 121.79 mm and the mean value for head length was 21.16 mm; at the Jarun site (N=237), the standard body length ranged from 48.00 mm to 124.00 mm, the mean value of the total body length was 121.69 mm, and the mean value of head length was 20.68 mm. Data on the total body length and mass of bleak from Çaygören reservoir (Balikesir, Turkey) indicated larger specimens in comparison with our sample. For males (N=346), the total body length ranged from 120.00 mm to 186.00 mm, and for females (N=367) from 124.00 mm to 196.00 mm. In terms of weight, it ranged from 26.44 g to 123.45 g in males and from 30.47 g to 125.28 g in females (Erdoğan and Torcu Koç, 2017).

Comparing these data with our results, it is evident that bleak from the Bosna River are smaller in size and, as far as the basic morphometric parameters are concerned, they are closest to those from the Timiş River in Romania. These results can be explained by the sampling period conducted during the winter so larger individuals are retreated to deeper water. Sampling was performed from the coast, in the coastal, shallower part of the Bosna River, and smaller fish were known to be retained in these parts of the river (Sofradžija, 2009).

Table 3. Relative values of morphometric characteristics of bleak given in % (n- number of individuals; Min- minimum value; Max- maximum value; AV-average value; SD- standard deviation). The meanings of abbreviations for morphometric characters can be found in the Material and Methods section.

Morphometric parameters	N=101			
	Min	**Max**	**AV**	**SD**
% of a-v (standard body length)				
a – b_2	108.88	148.58	123.84	4.95
c – g	46.29	107.33	57.60	7.78
g – d	6.85	14.18	10.05	1.24
m – n	27.38	59.68	46.19	3.93
o – p	41.97	81.84	65.40	4.96
q – r	9.77	25.96	19.79	2.98
t – v	12.46	30.14	18.49	2.99
H_1 – H_2	8.74	28.94	18.69	2.63
h_1 – h_2	3.44	11.11	7.99	1.19
i-l	17.03	29.81	24.62	1.92
% of i – l (head length)				
i – j	12.56	36.57	22.97	3.98
j – k	18.93	34.65	27.76	3.22
k – l	37.78	65.50	48.93	5.43

A research on the morphometric characteristics of bleak from the Sava River (Croatia) were conducted by Domitrović *et al.* (2004) and their results showed slightly higher mean values for the following parameters: the highest body height (22.58), the lowest body height (8.46) and the eye diameter (29.50). Regarding the total body length of the bleak from the Sava River (120.35) and the length of the head (20.43), higher mean values were observed for bleak from the Bosna River. Data (mean values) provided by Witkowski *et al.* (2015) on the morphometry of bleak from the Bistrica River (Poland) were partially different from our data, with values lower than ours for the head length (20.70), while the highest body height (25.80), the lowest body height (9.10), preorbital distance (31.50) and postorbital distance (55.80) had higher values than in bleak from the Bosna River. Relatively similar values were observed for antedorsal distance (55.60), anteventral distance (44.40), anteanal distance (63.30) and the eye diameter (27.50).

Fulton's condition factor (K)

The values of the Fulton's condition factor for bleak from the Bosna River ranged from 0.37 to 0.93 with a mean value of 0.61± 0.08, indicating that the fish were in a relatively poor condition. Such results can be explained by the fact that the sample was dominated by fish of smaller body size, sexually immature individuals whose condition factor is lower than that of sexually mature individuals. It should also be emphasized that fish sampling in the Bosna River was performed in winter when the environmental conditions were less favorable than during other seasons, especially with reference to nutrition. Such results were consistent with a well-known rule that the condition factor in adult fish decreased during periods of lower temperatures and/or less food availability. Also, the condition factor increases as the spawning period approaches, then decreases after spawning, and again increases, for the second time, after the spawning period, which is especially pronounced in females (Le Cren, as cited in Froese, 2006).

Piria (2007) offered similar observations for bleak from two sites from the Sava River (Medsava and Jarun) and concluded that Fulton's condition factor showed the highest value during summer months. At the Medsave site, mean values of this parameter ranged from 0.57 in March 2005 (N=41) to 0.84 in July 2005 (N=1). At Jarun site, the lowest mean values for the Fulton's condition factor were also found in March 2005, 0.53 (N=1), and the highest in June 2004, respectively, 0.83 (N=8). The same author noted that higher values in both sites were found in larger specimens. Similar values for the Fulton's condition factor were obtained from several localities of the Lonjsko Polje Nature Park (Bakota *et al.*, 2003), where mean K values ranged from 0.58 to 0.98. Ridanović *et al.* (2015) also gave data for Fulton's condition factor for bleak from several sites from the Sava River, where mean K values were as high as 1. Such low values of the condition factor for bleak of smaller body dimensions could be explained with growth coefficient (Lujić *et al.*, 2013). They stated that, in comparison to other fish species, the highest value of this coefficient was established for bleak, which indicated that this species most intensively grew in length in the first two years of life.

On the other hand, much higher values of the Fulton's condition factor were observed for bleak from Çaygören reservoir (Balikesir, Turkey) ranging from 1.60 for males (N=346) to 1.95 for females (N=367). The lowest values were recorded in June and the highest in March and February. Such results are explained by mechanisms related to energy conservation and storage in the pre-spawning period, during spawning and after spawning, as well as local environmental factors such as temperature, organic matter, availability and quality of food, as well as the type of aquatic system in which fish live (Erdoğan and Torcu Koç, 2017).

Length–weight relationship

The ratio of total body length and mass of bleak from the Bosna River is presented in Figure 3.

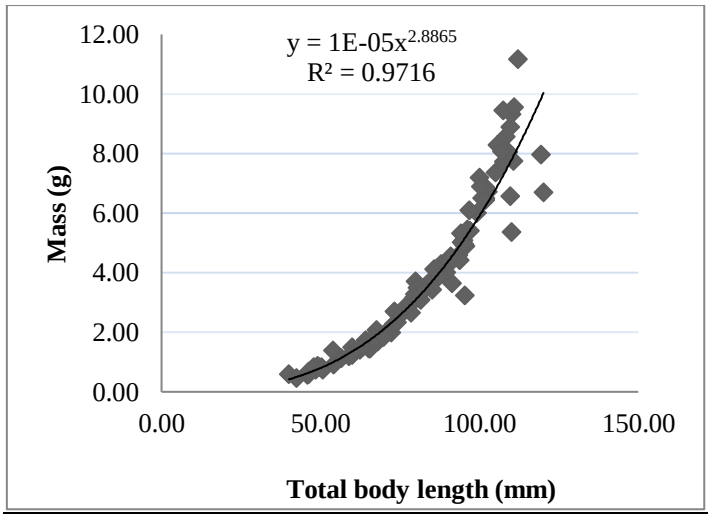

Figure 3. Length-weigth relationship for bleak from the Bosna River

Considering the value of b=2.8865 for bleak from the river Bosna, negative allometric growth (b <3) was noted. In other word, bleak in our sample grow faster in length than in mass, so as fish grow in length they become thinner, which fits into the growth factor data for bleak given by Lujić *et al.* (2013). Analyzing the relationship between total body length and body mass, a very high degree of correlation was observed between the two characters (R^2=0.9716). Similar data were obtained for the bleak of Çaygören reservoir (Balikesir, Turkey), where R^2 was 0.969 for females and 0.980 for males (Erdoğan and Torcu Koç, 2017), as well as for bleak from Finnish waters, where R^2 was 0.974 (Gamma and Niberg, 2017).

Meristic characteristics

The values of the analyzed meristic characteristics (the number of scales in the lateral line and the number of branched and unbranched rays in fins) are given in Table 4. In the same table, comparative data are provided according to available accounts of the same parameters.

Table 4. Review of meristic characteristics of bleak. The meaning of abbreviations for meristic characteristics is in the Material and Methods section (number of unbranched rays is denoted by Roman numbers and number of branched rays by Arabic numbers).

	Meristic characters				
References	*PD*	*PP*	*PV*	*PA*	*PC*
Vuković and Ivanović, 1971	III-IV, 7-9			III, 14-20	
Gąsowska, 1974	7-9			14-21	
Šorić, 1986	8			16-20	
Prokeš and Baruš (as cited in Doimitrović *et al.*, 2004)	6-10				
Baruš *et al.*, (as cited in Doimitrović *et al.*, 2004)	III-IV, 7-9				
Group of authors, 1949-1994 (as cited in Baruš *et al.*, 1998)	III, 6-10			III, 10-22	
Baruš *et al.*, 1998				16-21	
Keith i Allardi, 2001	II-IV, 7-9	I, 14-18	II, 7-8	III, 14-20	19
Simonović, 2001	III-IV, 7-9			III, 15-20	
Šorić, 2004	8			16-17	
Domitrović *et al.*, 2004	II-III, 8-10			16-20	
Kottelat and Freyhof, 2007				17-20½	
Witkowski *et al.*, 2015	7-9	12-15	7-9	16-21	
Our results	**III, 7-9**	**I, 10-17**	**II, 7-8**	**III, 15-20**	**18-21**

Analyzing the number of branched and unbranched rays in fin for bleak from the Bosna River and comparing the values with the available referential accounts, it was found that our results mostly fit the existing data on these parameters. The only discrepancy observed was the minimum number of branched rays of pectoral fin which was 10. This number was detected in only two individuals and the error that could occur during counting should not be ruled out.

According to Vuković and Ivanović (1971), the number of scales in lateral line for bleak ranged from 40 to 52. The same data was provided by Bogut *et al*. (2006), while Simonović (2001) obtained a larger range of variation, 45-55, which also fit the results obtained by our studies (44-55 scales for bleak from the Bosna River with a mean value of 46.93 ± 1.81). Similar data were given by Witkowski *et al.* (2015) for bleak from the Bistrica River (Poland) where the number of scales in the lateral line varied 46-53, while Gąsowska (1974) reported a range of variation form 45 to 56 for bleak from different waters of Poland (rivers, lakes, estuaries). The same author stated that the highest mean values for this parameter were observed for bleak from lakes (50.65), lower values were present in those from rivers (49.31), and the lowest for river mouths (48.82). The same author also recorded the correlation of the number of scales in the lateral line with climatic factors; respectively in colder conditions the number of scales usually decreased (Gąsowska, 1974). However, it should be noted that for these claims there is no data in terms of statistical significance. Czech authors (Baruš *et al.,* 1998) provided data from several sources (Berg, 1949; Oliva and Šafranek, 1962; Gasowska, 1974; Liška and Pivnička, 1985; Oliva *et al*., 1988; Prokes and Baruš, 1994) and they pointed out that the number of scales for bleak could vary from 38 to 59. The number of scales in the lateral line for bleak from the Sava River (Croatia) ranged from 44 to 50 (Domitrović *et al.,* 2004). Dimovski and Grupče (as cited in Domitrović *et al*., 2004) stated that inclusions from Lake Ohrid have 47-55 lateral scales, from Vardar River 42-51, from Dojran Lake 47-57, from Prespa Lake 47-60 and from the river Strumica 36-50, which in total indicated a possible variation from 36 to 60 scales. Data from the Czech key (Baruš *et al.,* as cited in Domitrović *et al.,* 2004) suggested a lower degree of variation (40-43) 44-55 (51-52). Šorić (1986, 2004) also provided data on the number of scales in the lateral line for bleak from two tributaries of the Western Morava River; the Ibar River (47-50 scales) and the Gruza River (47-51 scales).

CONCLUSIONS

Our research of morphometric and meristic characteristics of the bleak (*Alburnus alburnus*) from the Bosna River conducted in 2016 included a sample of 101 individuals. The analysis of the morphometric characteristics and comparison with the available referential accounts revealed that the bleak from the Bosna River had smaller body dimensions, where the total body length did not exceed 120.20 mm and the body weight was not greater than 11.17 g. Taking into account that the sampling was conducted in winter and covered mainly the coastal region of the river with shallow water, such results are not unexpected. The obtained values of Fulton's condition factor (range from 0.37 to 0.93 with mean value of 0.61) indicated that the bleak from the Bosna River were in a relatively poor condition, which was related to the high proportion of individuals of younger age, season of sampling (winter), and some environmental conditions, primarily temperature and nutrition. A high positive correlation was observed between the body weight and length (R^2=0.9716), while the coefficient *b* indicated a negative allometric growth type (b=2.8865). The values of the meristic parameters generally fit the already known data from the available referential

accounts, and a deviation was observed only for the minimum number of branched rays of pectoral fin.

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REFERENCES

AVP Sava (Agencija za vodno područje rijeke Save) [Agency for water area of Sava River], 2016. Plan upravljanja vodama za vodno područje rijeke Save u Federaciji Bosne i Hercegovine (2016–2021). [pdf] Sarajevo: Agencija za vodno područje rijeke Save. Available through http://www.voda.ba/udoc/planupravljanjavodama/Plan_upravljanja_vodama_za_vodno_podrucje_rijeke_Save_u_FBiH_(2016–2021).pdf [Accessed 24. 05. 2018.].

AVP Sava (Agencija za vodno područje rijeke Save) [Agency for water area of Sava River], 2018. Opšte karakteristike poplavnog područja priobalja donjeg toka rijeke Bosne, nizvodno od Modriče do Bosanskog Šamca. [pdf] Sarajevo: Agencija za vodno područje rijeke Save. Available through http://www.voda.ba/pp-bosna-modrica-samac [Accessed 10. 12. 2018.].

Bakota, R., Treer, T., Odak, T., Mrakovčić, M. and Ćaleta, M., 2003. Struktura i kondicija ihtiofaune Lonjskog polja. *Ribarstvo,* 61(1), pp.17–26.

Baruš, V., Prokeš, M. and Zukal, J., 1998. A biometric study of populations of the bleak (*Alburnus alburnus*) from the Czech Republic. *Folia Zoologica,* 47(2), pp.135–144.

Bogut, I., Novoselić, D. and Pavličević, J. 2006. *Biologija riba*. Osijek: Sveučilište Josipa Jurja Strossmayera, Mostar: Sveučilište u Mostaru.

Domitrović, Ž., Piria, M. and Treer, T., 2004. Morfološke osobine pet populacija riba iz gornjeg toka rijeke Save. *Ribarstvo,* 62(3), pp.109–119.

Erdoğan, *Z.* and Torcu Koç, H., 2017. An investigation on length-weight relationships, condition and reproduction of the bleak, *Alburnus alburnus* (L.) population in Çaygören Dam Lake (Balikesir), Turkey. *Journal of Balikesir University Institute of Science and Technology*, 19(1), pp.39–50.

Freyhof, J. and Kottelat, M., 2008. *Alburnus alburnus. The IUCN Red List of Threatened Species* 2008:e.T789A174775859. https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T789A174775859.en. [Accesssed 17.11.2018.].

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

Gama, J. and Nyberg, M., 2017. Length-weight relationships of six freshwater fish species from lake Kirkkojärvi, Finland. *Croatian Journal of Fisheries*, 75, pp.156–159.

Gąsowska, M., 1974. Biometric and ecological studies on the bleak, *Alburnus alburnus* (LINNAEUS) (*Pisces, Cyprinidaè*) from different bodies of water in Poland, in connexion with the geographic variability of this species. *Polska Akademia Nauk, Instytut Zoologii*, 31(4), pp. 373–405.

Georgiev, D., Zhelyazkov, G. and Georgieva, K., 2015. Sex and Size Structure of Roach (*Rutilus rutilus*) and Bleak (*Alburnus alburnus*) Populations in Yhrebchevo dam. *Ekologia Balcanica*, 7(2), pp.51–56.

Karachle, P.K. and Stergiou, K.I., 2012. Morphometrics and Allometry in Fishes. In. C. Wahl, ed. 2012. *Morphometrics*. Rijeka, Croatia: InTech. pp.65- 86.

Keith, P. and Allardi, J., (coords.), 2001. *Atlas des poissons d'eau douce de France*. Paris: Muséum national d'Histoire naturelle, (Patrimoines naturels, 47).

Kottelat, M. and Freyhof, J., 2007. *Handbook of European freshwater fishes*. Berlin, Germany: Kottelat, Cornol, Switzerland and Freyhof.

Lujić, J., Kostić, D., Bjelić-Čabrilo, O., Popović, E., Miljanović, B., Marinović, Z. and Marković, G., 2013. Ichtyofauna composition and population parameters of fish species from the special nature reserve „Koviljansko-Petrovaradinski rit" (Vojvodina, Srbija). *Turkish Journal of Fisheries and Aquatic Sciences*, 13, pp.665–673.

Piria, M., Treer, T., Tomljanović, T., Aničić, I., Safner, R., Šprem, N. and Matulić, D., 2006. Ishrana uklije (*Alburnus alburnus)* iz rijeke Save. Conference Proceedings, *41. Hrvatski i 1. Međunarodni znanstveni simpozij agronoma*, Opatija, Hrvatska, 13-17 February 2006. Poljoprivredni fakultet Sveučilišta J. J. Strossmayera u Osijeku, pp.531–532.

Piria, M., 2007. *Ekološki i biološki čimbenici ishrane ciprinidnih vrsta riba iz rijeke Save.* Ph.D. Agronomski fakultet, Sveučilište u Zagrebu.

Ridanovic, S., Nedic, Z. and Ridanovic, L., 2015. First observation of fish condition from Sava river in Bosnia and Herzegovina. *Journal of Survey in Fisheries Sciences*, 1(2), pp.27–32.

Riedel, R., Caskey, L.M. and Hurlbert, S.H., 2007. Length-weight relations and growth rates of dominant fishes of the Salton Sea: implications for predation by fish-eating birds. *Lake and Reservoir Management*, 23(5), pp.528–535.

Shakir, H.A., Qazi, J.I., Hussain, A. and Ali, S., 2010. Growth coefficient and condition factor of three carp species reared under semi-intensive culture. *Punjab University Journal of Zoology*, 25(1–2), pp.13–20.

Simonović, P., 2001. *Ribe Srbije*. Beograd: NNK International, Zavod za zaštitu prirode i Biološki fakultet.

Sofradžija, A., 2009. *Slatkovodne ribe Bosne i Hercegovine*. Sarajevo: Vijeće Kongresa bošnjačkih intelektualaca.

Stavrescu-Bedivan, M., Aioanei, F.T. and Vasile Scaeteanu, G., 2017. Length-weight relationships and condition factor of 11 fish species from the Timis River, Western Romania. *Agriculture & Forestry*, 63(4), pp.281–285.

Šorić, V., 1986. Natural hybrid *Alburnus alburnus* x *Leuciscus cephalus* in the Gruža Reservoir. *Biosystematika*, 12(2), pp.165–174.

Šorić, V., 2004. A natural hybrid of *Leuciscus cephalus* and *Alburnus alburnus* (Pisces, Cyprinidae) from the Ibar river (Western Serbia). *Archives of Biological Sci*ences, 56(1–2), pp.23–32.

Vinyoles, D., Robalo, J.I., de Sostoa, A., Almodovar, A., Elvira, B., Nicola, G.G., Fernandez-Delgado, C., Santos, C.S., Doadrio, I., Sarda-Palomera, F. and Almada, V.C., 2007. Spread of the alien bleak *Alburnus alburnus* (Linnaeus, 1758) (Actinopterygii, Cyprinidae) in the Iberian Peninsula: The role of reservoirs. *Graellsia*, 63(1), pp.101–110.

Vuković, T. and Ivanović, B., 1971. *Slatkovodne ribe Jugoslavije.* Sarajevo: Zemaljski muzej BiH.

Witkowski, A., Kotusz, J., Wawer, K., Stefaniak, J., Popiolek, M. and Blachuta, J., 2015. A natural hybrid of *Leuciscus leuciscus* (L.) and *Alburnus alburnus* (L.) (Osteichthyes: Cyprinidae) from the Bystrzyca River (Poland). *Annales Zoologici*, 65(2), pp.287–293.

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