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Drago MARIĆ[1], Katarina BURZANOVIĆ[2], Stevan MARIĆ[3*]

VARIABILITY OF LENGTH WEIGHT RELATIONSHIP AND CONDITION FACTOR OF THE EUROPEAN EEL (*Anguilla anguilla* L.) – CASE STUDY FROM THE LAKE SKADAR (MONTENEGRO)

SUMMARY

The results presented contribute to the knowledge about the length-weight relationships (LWR) of the European eel (*Anguilla anguilla*). When using the results presented in this study, it should borne in mind that the samples were taken during the year and the number of fish examined was relatively large. LWRs parameters are calculated for the two different length classis and found significant. In the present study, bigger specimens (45 cm) of European eel have value of growth coefficient b = 3.25. This value is significantly higher than the b = 3 showing that weight of this fish increases more than cube of its length (positive growth coeffient). The lesser specimens (<45 cm) of European eel have value of growth coefficient b = 2.54, and this value is significantly smaler than the b = 3. The relationship between total length (TL) and weight (W) was described by the equation:

Length <45 cm (n = 320), $Y = 0.0098x^{2.5398}$ $R^2 = 0.8362$

Length ≥45.1 cm (n = 346), $Y = 0.0007x^{3.2525}$ $R^2 = 0.8971$

The values of condition factor (CF) were ranged from 0.13-0.25 (average 17.0-18.5) and smalest were found in the December.

Analysis of the total sample, of any species, cannot show by what rule the population grows, if infrapopulation variability is present, because the studied value will depend on the number of individual subgroups. The estimations of LWRs shall be helpful in future works on by catch of fish species in Skadar Lake in Montenegro and Albania.

Keywords: European eel, LWR, CF, infrapopulation variability, seasonal cycle

[1]Drago Marić, University of Montenegro, Department of Biology, Faculty of Sciences, P.O. Box 328, 20000 Podgorica, MONTENEGRO.

[2]Katarina Burzanović, Ministry for Agriculture, Forestry and Water management, Directory for Fisheries, Rimski trg, 46, 81000 Podgorica, MONTENEGRO.

[3]Stevan Marić* (Coresponding autor: stevanmaric@nparkovi.me), National Parks of Montenegro, 81000 Podgorica, MONTENEGRO.

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INTRODUCTION

The European eel (*Anguilla anguilla*) is found and exploited in most European water bodies and a number of sites in northern Africa (Dekker, 2000). It inhabits the basin of Skadar Lake and small tributaries of the Adriatic Sea in Montenegro (Marić, 2019). European eel landings have decreased rapidly throughout Europe since the 1960s (ICES, 2019). The same applies for the Skadar Lake of Montenegro, where European eel the permanent decrease (R^2 = 0.76) over the entire period (70 years), (Marić, 2018).

Fishery management of European eel (*A. anguilla*) has received increasing attention by both the scientific community and fisheries agencies in the last years (ICES, 2019). *A. anguilla* has been recently listed in Annex B of CITES, and the European Council adopted a regulation (EC 1100/2007) aimed at recovering the stock through the drawing up of Eel Management Plans (EMPs) at a river basin scale. Montenegro has no long-term management plans. Basic information about this species is missing. Some biological characteristics are partial or analyzed on a small number of specimens, e.g. abundance, length-weight rationship, conditions, etc.

The length-weight relationship is very important for proper exploitation and management of the population of fish species (Anene, 2005). These data are needed to estimate growth rates, length and age structures, and other components of fish population dynamics (Kolher *et al*. 1995). Length-weight relationships allow fisheries scientists to convert growth-in-length equations to growth-in-weight in stock assessment models, estimate biomass from length frequency distributions, compare life history and morphological aspects of populations inhabiting different regions and calculate fish condition (Petrakis & Stergiou 1995; Vaslet *et al*. 2008; De Giosa *et al*. 2014; Özpiçak *et al*. 2018 Froese & Pauly 2020 and etc). The length-weight relationships of some fishes in Montenegrin waters have been studied, e.g. Milošević & Marić (2012); Milošević *et al*. (2012); Marić & Rakočević (2015); Marić & Burzanović (2021) studied the length-weight relationships of some fish species (e.g. *Rutilus* spp., *C. carpio*, *S. farioides*, *A. scoranza*) in the Skadar Lake watershad. In fisheries science, the condition factor is used in order to compare the “condition”, “fatness” or wellbeing of fish. It is based on the hypothesis that heavier fish of a particular length are in a better physiological condition (Bagenal, 1978). Condition factor is also a useful index for monitoring of feeding intensity, age, and growth rates in fish (Le Cren, 1951; Weatherley 1972; Marić & Burzanović 2021). It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live (Anene, 2005; Simon, 2007).

Insufficient knowledge of the growth pattern, as well as the condition of the *A. anguilla* in this lake is the main reason-goal of studying this species in this paper. The aim of this study was to evaluate the length-weight relationship and condition of the native European eel population from the Skadar Lake.

Consideration of the life-history strategies of the European eel should be of great significance to fisheries management, restoration and monitoring.

MATERIAL AND METHODS

Area and habitat study

Skadar Lake is a karst lake created by inundation of a karstic field. It is situated on the border of Montenegro and Albania, ⅔ of the lake belongs to Montenegro (Figure 1). It is situated between 18^{o} 41' and 19^{o} 47' of eastern geographical longitude and between 42^{o} 58' and 40^{o} 10' of northern geographical latitude, with the surface area that fluctuates seasonally from approximately 370 to 540 km^2 and water level also varies seasonally from 4.7 to 9.8 m above sea level. The shape of lake is elongated oval with peak width of circa 14 km at average water level, and it is approximately 44 km long (NW-SE direction), with the mean depth of 5 m (Beeton, 1981).

Figure **1.** Map of the Skadar Lake and the European eel distribution (marked with orange lines) in Montenegro.

Waters from the watershed reach the lake by ground or underground water courses, through a number of sublacustrine springs (so called “oka” – “eye”). The largest tributary of Skadar Lake is the Moraca River which brings around 62% of water, while the waters flow away from the lake into the sea by the Bojana River; its average flowing through is over 300 m^3/sec. Average monthly water temperatures range 5-7 ^oC in winter, to 25-28 ^oC in summer. During the summer the transparency of lake waters is 2-3 meters, but in winter it increases reaching up to 5 meters (Petrović, 1981; Kastratović, 2018).

The lake represents one of the most important centers of biodiversity for Western Balkan and SouthEastern Europe (Marić & Rakočević 2010) with more than 100 species of water birds (Vizi, 2018) and 41 (34 autohtonusand 7 alohtonus) fish species (Marić, 2019). Fish in this watershed have significant economic potential. A large number of species are important mainly for sports–recreational fishing, whereas a lesser number are economically useful in terms of gaining profit. If we observe the lake in its entirety, it should be stated that there is little precise and reliable data on the catch of fish (Marić, 2018).

The average chlorophyll a concentration indicates mesotrophic conditions in Lake Skadar, but during midsummer, when the highest phytoplankton abundance and biomass occurs, the trophic level of the lake increases to eutrophy (Rakočević, 2018).

Data

Data of 666 specimens of European eel (*A. anguilla*) were collected in the Skadar Lake. Fishes were collected during autumn (early December), Spring (March and April) and summer (August) i.e. 5 samples were collected in 2014-2015. Sampling was carried out from boats by means of 4.0 kW electric stunning devices; these devices supplied continuous pulsating current (direct current), along rocky shores and the borders of reed areas. Sampling was conducted from March 2014 to April 2015. All eels were killed by freezing and then it were immediately freshly measured. Total length (cm) of each fish was measured from the tip of the snout (mouth closed) to the extended tip of the caudal fin using a measuring board (±0.1 mm). Body weight (fresh) was recorded to the nearest gram using electronic balance (±0.1 g).

The relation between the weight and the length is given by the equation $W = aL^b$, where *W* is the total weight in grams, *L* the total length in centimetres, *a* the factor and *b* the exponent (Ricker, 1975). The parameters *a* and *b* of the *L-W* relationships were estimated by the power functions (regression method). The deviation of regression coefficient *b* from 3 was tested by calculating t value, $t = (b-3)/Sb$, where Sb was given as: $Sb = \sqrt{[(SW / SL) - b^2]} / n-2$, where *SW* is the variance of the body weight, *sL*, the variance of the total length and n the sample (Lawson *et al*. 2013). Because the LWR for the same fish species is often different between adults and juveniles (Safran, 1992; Marić & Rakočević 2015; Marić & Burzanović 2021), the LWR relationships were calculated separately by length groups. Four size classes were established units and included: eel less than 40 cm TL, those between 40.1 - 45.0 cm TL, than 45.1 - 50.0 cm TL and those greater than 50.1 cm TL.

Condition factor (CF) of the eels was calculated using the formula of Fulton (1904): CF = W^x $100/L^3$, where, CF - Condition factor; W – total weight of body (in g); L – total lenght of body (in cm), the factor 100 is used to bring K close to unity (Froese, 2006). The coefficient of determination (R^2) was used as an indicator of the quality of the regression (Scherrer, 1984).

Statistical methods used for data analysis included the usual calculations of means and standard deviations. Analysis of variance (ANOVA) and the Tukey HSD test were used to assess differences between observed variables (mean length, mean condition factor and *b* the exponent) in the different periods (five). A t-test was used for testing significant of the coefficient of determination and the significant difference of *b* values from 3, which represent isometric growth. The statistical analyses, e.g. two-way ANOVA and t-test, were performed with the statistical program SPSS (Statistical Package for the Social Sciences) version 9.0. All the statistical analyses were considered at a significance level of 5%; 1% or % 0.1 (P <0.05; P <0.01 or P <0.001).

Ethical Statement

This study does not need any formal consent as the experimental fish because fishing is carried out commercially in Montenegro.

RESULTS AND DISCUSSION

Table 1. reports the basic statistics of length (TL) and weight (W) data (by year) for the 2014-2015 European eel samples from the Skadar Lake. The sample was composed of 666 specimens. The TL and W of the specimens analyzed varied between 30.0 and 67.0 cm, 51.5 and 740.0 g, respectively.

Table **1**. Basic statistics of length, weight, standard deviation (±) and n data (by year) from eel samples from March 2014 to April 2015

Periods	N	TL: Min-max	W: Min-max	TL and W: Average
March (total)	118	40.0 - 67.0	120.0-740.0	53.08 (293.06)
March > 45	103			52.58 ±6.15 (±SD)
June (total)	209	31.1 - 60.0	53.8 - 408.4	42.81 (153.87)
June>45	79			50.14 ±3.78
August (total)	144	30.0 - 64.5	51.5 - 500.0	43.68 (164.84)
August >45	52			50.9±5.06
December (total)	116	40.1 - 63.0	105.0 - 580.0	49.73 (229.79)
December >45	76			52.18 ±5.84
April (total)	120	32.5 - 61.0	55.8 - 553	48.09 (214.30)
April>45	73			53.58 ±5.28

Average length of the investigated eel from five periods ranged from 42.81 to 53.08 mm and body weight from 153.78 to 293.06 g. ANOVA show a statistically significant difference (P < 0.01) between five periods (f = 3.75., P =

0.005.,) for total length. Post Hoc Tukey (Tukey's HSD) test show a statistically significant difference between April and June (Q = 5.01, P = 0.004), than April and August (Q = 3.9, P = 0.048). No signfcant differences were found between the average leigth of the investigated European eel biger than 45 cm from five periods ($P > 0.05$).

The Fulton's condition faktor (CF) varied from 0.13 to 0.25 (Table 2). The condition faktor undergoes minor changes in specimens belonging to different size classes. ANOVA show a statistically significant difference ($P < 0.01$) between five periods (f = 5.54., P = 0.002) for CF.

Table **2**. The monthly values of the condition factor for eel from March 2014 to April 2015

Periods	**N**	**Min**	**Max**	**Average (SD)**
Mart (total)	102	0.15	0.25	0.183 (0.022)
June (total)	209	0.14	0.23	0.184 (0.019)
August (total)	119	0.13	0.23	0.181 (0.02)
December (total)	116	0.14	0.22	0.175 (0.02)
April (total)	120	0.13	0.22	0.178 (0.019)

The smallest values of condition factor were recorded in the specimens from period December (Table 2). Post Hoc Tukey (Tukey's HSD) test show a statistically significant difference between three group/pairs: June vs December (Q = 5.97, P = 0.00027), June vs April: Q = 4.14, P = 0.02914), and August vs December (Q = 4.09, P = 0.03256). Differences is not significant at $p< 0.01$ between five periods in specimens large than 45 cm.

The number of individuals sampled (N), the length and weight ranges, parameters a and b of the length-weight relationships and the determination coefficient (R^2) for the five periods are given in Table 3. According to LWRs determined for yearly data (2014-2015) the *A. anguilla*, exhibited pozitive allometric growth for specimens biger than 45 cm, because b value was always bigger than 3 for each month of observation (Table 3). The length-weight relationship for the pooled data (N = 346) is presented in Fig. 3.

The relationship between total length and weight showed a strong pozitive correlation ($R^2 > 0.90$, $P < 0.001$, Table 3) for all size classes > 45 cm Tl. Within the size range of length lesser then 40 cm and weight lesser then 150g, the European eel appeared not to follow the cube law (b = 2.56 - 2.85). This value of b was significantly lesser than 3 ($P < 0.001$). In size classis of length lesser than 45 cm (and 200 g) value of b varied between 2.8677 - 2.7966. The allometric exponent b of size classis lesser than 45 cm is greater than that of size classis lesser than 40cm, buth both exhibited negative gowth parern, which shows that they increase in weight at a comparatively lower rate than the larger fish. The relationship between Total length and weight showed pozitive correlation (R^2 = 0.678 - 0.94, $P < 0.01$, Table 3) for all size clasis.

Table **3**. Values of *α* and *b* parameters and R^2 in separate size length for months/periods

Periods	**N**	***a***	***b***	R^2
March (45 - 70 cm)	102	0.0006	3.2843	0.9232
June (30 - 40 cm, < 120 g)	58	0.0078	2.5910	0.8125
June (30 - 45 cm)	130	0.0030	2.8677	0.8709
June (40 - 50 cm)	120	0.0018	2.9943	0.7818
June (45 - 60 cm)	79	0.0004	3.3977	0.9053
June (50 - 60 cm)	31	0.0005	3.3578	0.678
August (30 - 40 cm < 120 g)	36	0.0085	2.5621	0.7616
August (30 - 45)	67	0.0037	2.7966	0.8565
August (40 - 50 cm)	50	0.0019	2.9771	0.7688
August (40 - 65 cm)	80	0.0009	3.1815	0.9393
August (45 - 65 cm)	52	0.0007	3.2331	0.9172
December (40 - 50 cm)	65	0.0013	3.0677	0.7406
December (45 - 67)	76	0.0010	3.2188	0.9157
December (50 -70 cm)	51	0.0008	3.1871	0.9329
April (30 - 40 cm)	20	0.0019	2.8484	0.8700
April (45 - 65 cm)	73	0.0008	3.1881	0.9002

The figure 2 and 3 show that in relation to length, fish of the 45 - 67 cm group increase in weight at a higher rate than fish of the smaller size groups (< 45). The t-tests shoued that the regression coefficients of the length-weight relationship in both length group differed significantly from 3.

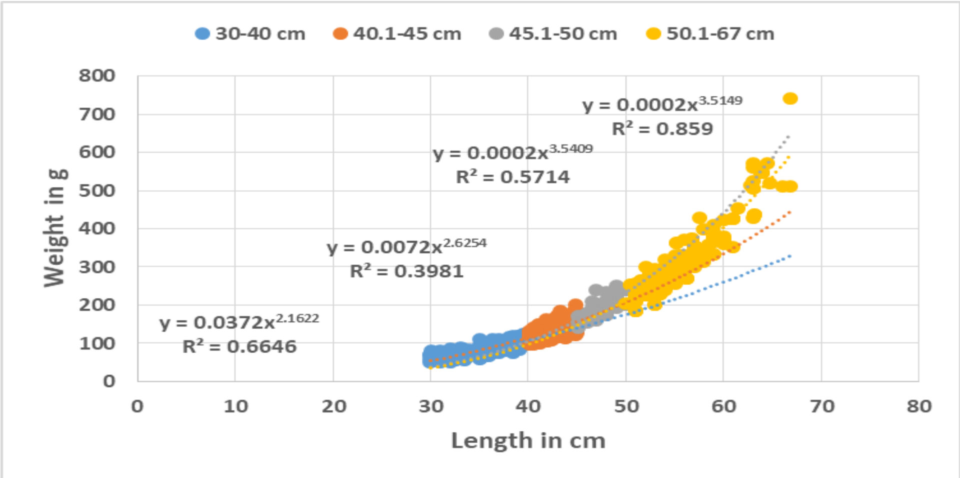

Figure **2**. Length-weight relationship for European eel for four length classes

Data from Table 3 as well as figure 2 showed that the same equation would not fit the data for the entire length range and that break occurred around the 45 cm. This break, a change in growth, also shows the coefficient of determination (R^2) and it is the smallest (greater variability in weight) in individuals from the length groups of 40 - 45 cm. R^2 values of 0.40 and 0.46 are at the limit of statistical significance ($0.05 < P < 0.01$), which shows a large irregularity in the growth of individuals from this length group.

After analysis in multiple size classis, it proved to be justified to single out only two groups (Figure 3). The first group is a group of specimens < 45 cm long and 200 g. weight and the second group are individuals > 45 cm Tl. We concluded that no single regression would adequately describe the length-weight relationship for the European eel in Skadar Lake and separate estimates were therefore made for two different length classes (groups), as mentioned below:

Length <45 cm (n = 320), $Y = 0.0098x^{2.5398}$ $R^2 = 0.8362$

Length ≥45.1 cm (n = 346), $Y = 0.0007x^{3.2525}$ $R^2 = 0.8971$

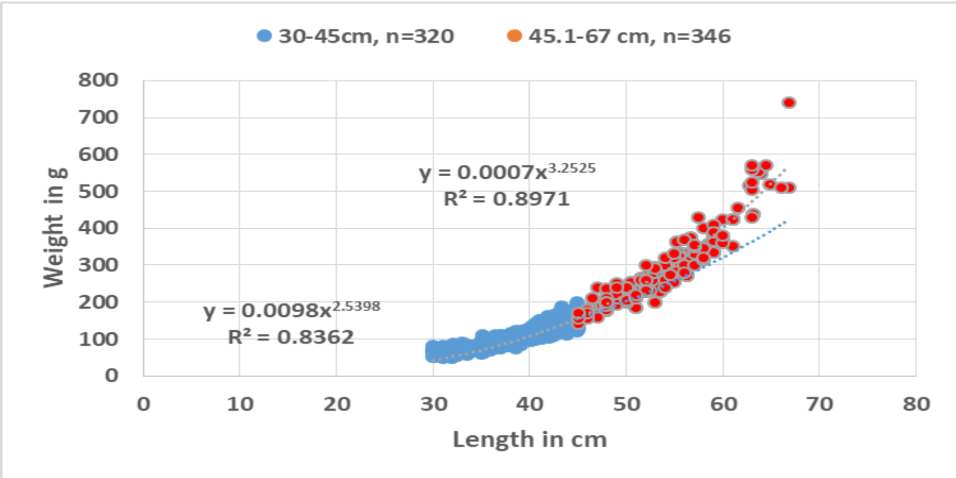

Figure **3**. Length-weight relationship for European eel for two size classis

DISCUSSION

There are many studies on biology of European eel in fresh waters (for example: Tesch, 1977; Dekker, 2004; Bevacqua, 2008; Castaldelli *et al*. 2014; Silm *et al*. 2017), but the ecology and biology of European eel in Montenegrin waters has received comparatively little attention. Unfortunately, there is no even data about the weigth-length relationship and the condition of European eel in this area. A common practice in freshwater fisheries biology is to scrutinize fish condition as an indicator of wellbeing and for comparing populations or stocks. The weight–length relationship and condition factor of the European eel, *A, anquilla*, were studied in specimens from Skadar Lake during the five period. A lot of work on the ratio of length and weight has been done on European eel found in the world, but in many works the dependence on length has not been analyzed (https://www.fishbase.se/ Search.php). There are only two studies regarding the biology of fishes from the Skadar Lake drainage, in terms of growth related to differences in the length range (Marić & Rakočević 2015; Marić & Burzanović 2021).

The condition of fish and their related length-weight relationship are widely used parameters which enhance the understanding of their general state, growth, survival, maturity and reproduction (Richter *et al*. 2000; Frose, 2006; Kharat *et al*. 2008; Milošević & Marić 2012). These parameters are also broadly used in the estimation of weight from the length, conversion of growth in length equations to growth in weight equations in stock assessment models, estimation of biomass from the length, indication of sex and differences between regions, and for comparison of the individuals of the same species (Bagenal & Tesch 1978; Gonçalves *et al*. 1997; Rawat *et al*. 2014).

The current paper presents data on the weigth-length relationship and the condition of European eel in Skadar Lake, during the annual cycle are analyzed in detail. Also, variability in relation to size was analyzed in detail. The LWR value was found to vary exclusively with body size (Table 3, Fig. 2) without varying beyond the corresponding range of allometry for the analyzed group during the annual cycle. As detailed research or research in this way has generally not been done, it represent the first data on this species in Skadar Lake. For the population from Skadar Lake, Milošević & Mrdak (2016) report LWR data and state that the population has negative allometry as a growth model. However, the data from that work show that both small (11.2 cm and 2.3 g) and larger specimens (79.5 cm and 930.5 g) were analyzed in the sample. For young European eels that are being prepared or already on their way to freshwater, Hegediš (2007) states the values for LWR, i.e. coefficient *b* less than 3 (about 2.6), which corresponds to negative allometry as a growth model, which was also found in this paper for European eels less than 40 cm. The results of our research differ significantly from most of the available data in the literature. In the literature and in the fish base, data are presented for all specimens together, for the population, and not by length. Often these results are shown on a small number of specimens, which is not in line with the recommendations suggested (100 specimens) by Froese (2006) and as such can give a distorted picture of the growth of this and other species. Length-weight relationships are not constant over the year and Length-weight relationships parameter may vary significantly due to biological, food availability, temporal and sampling factors, health and sex (Bagenal & Tesch 1978; Froese, 2006). Data from this paper were made on a large number of specimens, over 660, (at least 100 per period) and are in accordance with the recommendation of Froese (2006). They show that specimens up to 45 cm have negative allometry, and larger specimens have positive allometry at all times of the year. Partial analysis by length groups in the range of 10 cm per group, and even less (5 cm) if represented with a satisfactory number of specimens, showed that even the number of specimens in the group affects the value of the coefficient *b*, or the pattern of allometric-isometric growth. There are a lot of data in the literature, for several species, which show that many factors affect the value of *b* (Castadelli *et al*. 2014; Boulenger *et al*. 2015; Rawat *et al*. 2014). To study variability among populations and determine causes, intra-population variability must be analyzed first, i.e. by groups as done in this paper. Such an analysis shows a sharp boundary of differences between individual groups. Young specimens up to 45 cm were found to have negative allometry as a growth model. Separate length classes from 40 to 50 cm, depending on the season, have negative allometry to isometry (b = 2.9771 to 3.0677), however, all groups of 45 – 50 cm or larger than 45 cm have positive allometry. It should be noted that the youngest age class has not been studied, as well as that Hegediš (2007) states negative allometry for it. All this suggests that young individuals up to 45 cm grow according to the principle of negative allometry. It is interesting to note that the literature (Dekker *et al*. 1998) states that the limit value for the minimum allowable measure is usually 45 cm, although in some countries the minimum length allowed for hunting is 40 cm. This limit value (45) could be a good indicator for legislation in terms of illegal lengths in economic hunting.

According to many authors (Penàz & Tesch 1970; Poole & Reynolds 1996; Holmgren *et al*. 1997; Rawat *et al*. 2017), the growth of females in fish is significantly different from that of males. If we analyze the biology of this species (e.g. Tesch 1977; Dekker *et al*. 1998; Bevacqua *et al*. 2006; Melià *et al*. 2006; Silm *et al.* 2017), it can be seen that males mature first, i.e. they mature at shorter lengths, while in some (Dekker *et al*. 1998; Fernéndez-Delgado *et al*. 2006) it is stated that all specimens in freshwater larger than 45 cm are females. In the Asi River in Turkey, males larger than the above mentioned dimensions have been found, but they are few and this is explained by the good conditions for this species in the abovementioned river (Yalçin-Özdilek *et al*. 2006). According to van Ginneken *et al*. (2007) yellow eels grow and feed in continental waters in this pre-reproductive stage for a variable number of years, until they reach maturation size (around 400 mm for males and 600 for females). Boulenger *et al*. (2015) report mainly negative allometry for males and positive for females for many European waters (six countries, 13 basins). Isometry was found in only some waters and positive allometry for males in one. This means that males grow more slowly, i.e. that they are smaller in size than females, but also that they mature earlier and go to spawn (Dekker *et al*. 1998; Yalçin-Özdilek *et al*. 2006; van Ginneken *et al*. 2007). Because of all these differences when comparing, Kangur (1998), Matthews *et al*. (2003) analyzed only female growth. According to these data, our results would indicate that all specimens larger than 45 cm in Skadar Lake are females.

In terms of age, i.e. specimens of which age remain in lagoons and freshwaters, there is great disagreement. According to some, males live up to 4 - 5 years in freshwater, and females longer, while according to others, both males and females live more than ten years; even the age of over 50 is stated (Poole & Reynolds 1996; Simon, 2015). As sex and age were not studied in this paper, only on the basis of LWR can it be assumed that specimens with positive growth allometry are females. In contrast, specimens less than 40 cm would be young specimens in which the silvering process does not occur or is just beginning, and in specimens 40 to 45 cm the maturation process is likely to occur, primarily in males. This assumption for support also has a very large variability within this group, so at the same lengths we find specimens over 50% heavier than each other. This inequality is likely to affect the differences in LWR between periods in this length class (Table 3). If we keep in mind that mature specimens, primarily males (Dekker *et al*. 1998; Yalçin-Özdilek *et al*. 2006), go to spawn during the autumn period (November-December), it is logical to assume that poorly fed immature specimens, of the same length, remain in Lake Skadar until the next spawning season. The lowest value of CF was recorded in December (0.17) and the differences compared to other periods are statistically significant. According to Fernéndez-Delgado *et al*. (2006) European eel growth stagnates during the winter. The above mentioned could indicate that European eels that are up to 40 cm long are at least one year younger than those that are 40 - 45 cm long. It could also be assumed that European eels up to 45 cm long are significantly younger than those whose lengths are greater than 45 and 50 cm, respectively. If we add to this the already mentioned data that the growing eels are probably females, then it is understandable that there are these differences in the growth pattern (negative and positive allometry) between the studied groups in Skadar Lake. All of the above indicates that the values and form of growth (*b*) of an eel population may be good indicators of multiple biological characteristics that are indirectly studied and concluded. These results are suitable for the estimation of length-weight relationship since, the values of *b* are within the range of values of this parameter usually estimated in fishes, which according to Froese (2006) lies between 2.5 and 3.5.

In studies of population dynamics high condition factor values shows of favorable environmental conditions (such as: habitat and prey availability) and low values indicate less favorable environmental conditions (Blackwell *et al*. 2000). Analysis of the seasonal trend in the condition factor (CF) of the European eel in Lake Skadar reveals that august is the most favourable season, and that the population displays its worst condition in winter. In summer, the greater availability of food and the favourable weather conditions permit rapid growth and the accumulation of reserves of fat; this justifi as the high value of CF recorded in this period. Beside the specimens from November that have the lowest nutrition, the specimens from April also have lower values compared to other periods. As it is known, and already mentioned above, that European eels migrate to the sea during late autumn and early winter for spawning (Dekker *et al*. 1998; Davidsen *et al*. 2011; Monteiro *et al*. 2020), it can be assumed that those that are better fed in that period already migrated, and those who are less fed remained, so CF is therefore significantly different from those from the period of March, June and August. Condition factor compares the wellbeing of a fish and is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal & Tesch 1978). Certain differences between March of one year and April of the other can be attributed to the differences in the external environment in which these groups grew and fed. According to Castaldelli *et al*. (2014), due to reduced competition, after migrations in November and December, European eels have more favorable conditions for growth, so the differences found in eels in Skadar Lake in the periods of March of one year and April of the other may be due to reduced number in that period, in this case in March 2015. There are no precise data on the number of European eels in Skadar Lake, and data on general conditions in the studied period are scarce, so they are not suitable for further comparison.

In many species, CF has higher values in the autumn (late autumn) period than in others, although this depends on the species, more often on the spawning period. Cyprinid species have the highest CF just before spawning (Erk'akan *et al*. 2013; Milošević & Marić 2012; etc.), which is in spring, while salmonid species have the highest CF just in the period when the eel has the lowest value (Rawat *et al*. 2014; Jan *et al*. 2018). In this case, specimens with lower CF than others will probably not spawn, ie. go to spawn that year precisely because of poor nutrition and they remain for at least another vegetative year. Therefore, poorly fed specimens remain in fresh water during the winter period, when, as a rule, there is less food in Skadar Lake (Rakočević, 2018). This has the effect that CF increases significantly during the spring period, so in spring and summer it has significantly higher values than during autumn and winter. According to Fernéndez-Delgado *et al*. (2006) the growth of eels stagnates during the winter, although it is generally known that in continental waters during the winter all fish have a slow growth or the growth is interrupted (Marić, 2019). According to Bagenal & Tesch (1978), the higher nutrition of a group indicates that the conditions in a given water facility are more favorable for that age group than for others. For European eels from Skadar Lake, therefore, the conditions are more favorable for larger specimens. As it is known that large European eels feed on fish (Rasmussen & Therkildsen 1979; Barak & Mason 1992; Mann & Blackburn 1991; Golani *et al*. 1988; Yalçin-Özdilek & Solak 2007), and that there is a higher number of fish species in Skadar Lake, including those that do not grow more than 10-15 cm (Marić, 2019), it is clear that the conditions for feeding of large European eels in Skadar Lake are very favorable. Also, as most species in this lake spawn during the spring (Marić, 2019), then the concentration of young fish is the highest, which represents ideal conditions for feeding of eels, but also other species. No statistically significant differences were found between the smaller and larger ones in that period, and all groups had a high CF (0.18).

CONCLUSIONS

The data showed that the same equation LWRs would not fit the data for the entire length range for the *A. anguilla*. After analysis in multiple size classis, it proved to be justified to single out only two groups and that break occurred around the 45 cm. The first group is a group of specimens < 45 cm long and 200 g. weight (negative allometric growth) and the second group are individuals > 45 cm TL (pozitive allometric growth). This break, a change in growth, also shows the coefficient of determination (R^2) and it is the smallest in individuals from the length groups of 40-45 cm, which shows a large irregularity (greater variability in weight) in the growth of individuals from this length group. The condition faktor undergoes minor changes in specimens belonging to different size classes. ANOVA show a statistically significant difference ($P < 0.01$) between five periods (f= 5.54, p = 0.002) for CF. The smallest values of condition factor were recorded in the specimens from period December. Differences is not significant at $P < 0.01$ between five periods in specimens large than 45 cm. The results presented contribute to the knowledge about the weight-length relationships of the European eel. When using the results presented in this study, it should borne in mind that the samples were taken during the year and the number of fish examined was relatively large. The estimations of LWRs shall be helpful in future works on by catch of fish species in the Skadar Lake in Montenegro and Albania.

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