

Danilo MRDAK¹,
Stefan RALEVIĆ², Dragana MILOŠEVIĆ¹

LENGTH-WEIGHT RELATIONSHIP OF FOUR FISH SPECIES FROM RIVER MORAČA, MONTENEGRO

SUMMARY

This study provides data on the length-weight relationships (LWR) of four fish species: *Barbus rebeli* Koller, 1926, *Chondrostoma ohridanum* Karaman, S., 1924, *Pachychilon pictum* (Heckel & Kner, 1858) and *Telestes montenegrinus* (Vuković, 1963) from River Morača, Montenegro. Also, the paper provides the first comprehensive data of LWRs for endemic species for *Telestes montenegrinus* for which no LWR information was available in Fish Base. Values of b parameter ranged from 2.613 to 3.343, while values of a parameter ranged from 0.004-0.038. The results of this study could provide some additional insight into the ecology of the species and useful information for fisheries management in the studied river.

Keywords: Adriatic basin, regression, fisheries, growth, ecology

INTRODUCTION

The autochthonous ichthyofauna of the Adriatic basin of Montenegro consists of 43 species, while 14 of them are non-native species (Marić, 2019). The total length of large rivers and their tributaries in Montenegro is about 1700 km or about 2100 ha of water surface (Burić, 2010). Their special value is their good water quality, so they also represent a rich potential resource for both recreational fishing and aquaculture. The Morača River is the largest river in the Adriatic Basin of Montenegro and largest tributary of Skadar Lake which brings around 62% of water to the Lake (Marić *et al.* 2022). The Morača River is one of the few free-flowing rivers remaining in Europe. It is a biodiversity hotspot: home to several protected fish species such as the endangered endemic species, *Gobio skadarensis* Karaman, S., 1936, found only in Lake Skadar and the lower part of River Morača. The autochthonous ichthyofauna of the River Morača is represented by 24 species (Marić, 2019). Until now, there were no available data

¹Danilo Mrdak (corresponding author: danilomrdak@gmail.com), Department of Biology, Faculty of Natural Sciences and Mathematics, University of Montenegro, Podgorica, MONTENEGRO;

²Stefan Ralević, Natural History Museum of Montenegro. MONTENEGRO;

Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.

Received: 14/06/2023

Accepted: 28/08/2023

on LWRs of fish species from river Morača except for the *Salmo farioides*, Karaman, S., 1937 (Marić and Rakočević, 2015). So far data on the investigate species from the study area was presented as data on presence and distribution (Marić, St. *et al.*, 2010; Marić and Milošević, 2011; Marić, 2019) except for the *T. montenegrinus* which is endemic species for Skadar Lake basin and was subject of some biological and ecological investigation (Drecun *et al.*, 1985; Krivokapić, 1992; Krivokapić, 1998; Krivokapić, 2002, 2002 a; Krivokapić, 2003, 2003 a). Length-weight (L-W) relationship is one of the most widely used methods in fisheries research and its importance has been well documented. A LWRs study for a species can provide important insights into the ecology of the species (Froese, 2006). This parameter can be used to assess the well-being of individuals and is a useful tool in environmental monitoring programs, also (King, 2007).

This paper aimed to report for the first-time length-weight parameters for four species from river Morača, including one endemic for which no estimates were available in Fish Base (Froese and Pauly, 2014).

MATERIAL AND METHODS

The Morača River originates at an elevation of 975 m above sea level (Ljevište), by merging a large number of occasional and permanent streams, which flow from the eastern slopes of mountains Zebalac, Šuplja stijena and the northern slopes of Moračka Kapa Mt. (Drecun *et al.*, 1985) (Fig 1). The total length of the Morača River (from the spring to Skadar Lake) is 97 km. The area of the Morača River Basin is 3,257 km² (Hrvačević, 2004) and most of it (about 93%) is located in Montenegro. Only the upper part of the Cijevna River Basin is located in Albania. Morača River can be divided into three parts by environmental conditions (physical-chemical environmental parameters): the upper part (from the spring to Medjuriječje), the middle part (from Medjuriječje to Podgorica) and the lower part (from Podgorica to Skadar Lake) (Burić *et al.*, 2010).

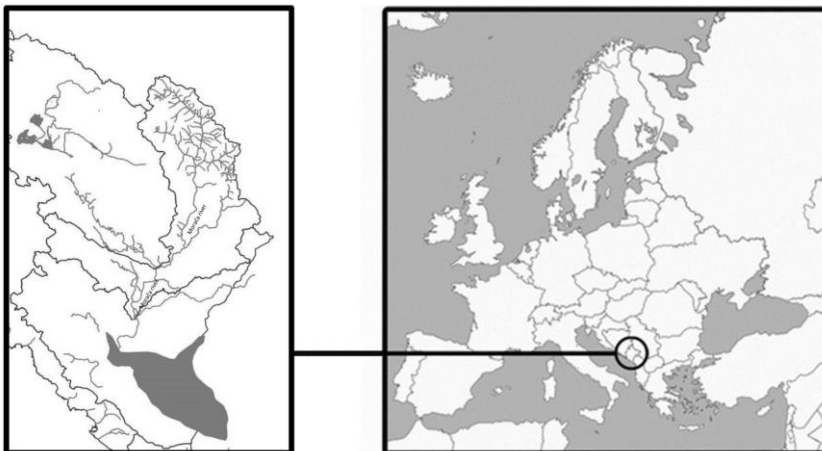


Figure 1. Morača river within the Adriatic basin of Montenegro

Sampling

Research on the Morača River was conducted during the 2019. Fish were sampled by electrofishing and commercial or standard benthic MMG nets (European standard EN 14757 - European Committee for Standardization 2015). A standard electrofishing gear (SUSAN-735MP) was employed according to technical instructions. Species were identified in the field, measured to the nearest 1 mm (total length, TL) and weigh to the nearest 0.1 g (weight, W). The mathematical function for estimation of LWRs was (Ricker, 1975): $W=aL^b$, where W is total weight (in g); L is total length (TL, in cm); a and b are the coefficients of the functional regression between W and L. The 95% confidence intervals (CIs) of the parameters and the statistical significance of the regression relationship (r^2) were estimated. The values of function parameters a and b were estimated by linear regression analysis based on the log transformed equation $\log W=\log a+b(\log L)$ (Ricker, 1975). The determination coefficient (r^2) was used as an indicator of the quality of the linear regressions.

RESULTS AND DISCUSSION

The sample size, the minimum, maximum, and mean lengths and weights, the values of a and b with their respective 95% confidence limits and the coefficient of determination r^2 for each species are given in Table 1.

Table 1. Descriptive statistics and estimated parameters of LWR for four freshwater fishes from River Morača; *: indicates a difference of b value from 3 (t-test; $p<0.005$)

Species	N	Length (cm)		Weight (gr)		Regression parameters		
		Min	Max	Min	Max	b	a	r^2
<i>Barbus rebeli</i>	202	8.7	24.1	12.1	188.1	2.613*	0.038	0.955
<i>Chondrostoma ohridanum</i>	50	14.8	31.1	28.9	257.8	3.025	0.008	0.974
<i>Pachychilon pictum</i>	56	7.5	18.1	3.8	72.3	3.343*	0.004	0.981
<i>Telestes montenegrinus</i>	85	9.1	16.7	9.8	49.6	2.776*	0.019	0.994

The b values ranged from 2.613 for *Barbus rebeli* to 3.343 for *Pachychilon pictum*. The results of this study are in accordance with Froese (2006), who reported that b values for teleost fish should fall within the expected range of 2.5 and 3.5. For one species, the b values were higher than 3 (t-test; $p<0.05$), for two the b values were lower than 3 (t-test; $p<0.05$), while for *Chondrostoma ohridanum* the b values of the L-W relationships were 3 (Table 1). Values of a parameter ranged from 0.004-0.038. Froese (2006) demonstrate through a meta-analysis that 90% of the intercept values ranged between 0.001 and 0.05. In our study, all species showed a values within the range presented by Froese (2006).

For *C. ohridanum* the results of this study are in concordance with Milošević and Mrdak (2016) who reported b value for *C. ohridanum* from Lake Skadar ($b=3.040$). For *B. rebeli* and *P. pictum* this data represent the first LWRs data from Montenegro. We found negative allometric growth for *B. rebeli*, ($b=2.613$). These results differ from the available results of Jordanova *et al.*, 2020 who reported almost isometric growth for *B. rebeli* ($b=2.994$) from Crn Drim (Macedonia). For *P. pictum* we found positive allometric growth ($b=3.343$). These results are in concordance with the available data for this species from Ohrid Lake and artificial Lake Debar (North Macedonia), respectively ($b=3.285$; $b=3.110$) (Milošević and Talevski, 2016). In general, the variations in LWRs of fishes may occur according to sex, gonad maturity, season, habitat type, health, food availability, environmental condition, degree of stomach fullness, differences in the length range of the caught specimens, sampling procedure and fishing gear (Bagenal and Tesch, 1978; Wootton, 1990; Froese, 2006). Also, field measurement can be fluctuating according to differences in fish surface wetness; boat movements and other adverse environmental conditions (Gutreuter and Krzoslen, 1994).

It is noteworthy that for *Telestes montenegrinus*, which is endemic species for the Skadar Lake basin, this data represents the first description of LWRs based on Fish Base (Froese and Pauly, 2014) Species is Natura 2000 species, also.

CONCLUSIONS

In conclusion, this study provides information on length-weight relationships of four freshwater fish from the Morača River, Montenegro. The length-weight relationship for *Telestes montenegrinus*, which is endemic species for the Skadar Lake basin is provided for the first time. The results of this study could provide data of the relative condition of fish population and fisheries management in the studied river and some additional insight into the conservation of these species.

ACKNOWLEDGEMENTS

The data for this paper were collected in the frame of the research for the need of producing to the “Fishery management plan for the catchment area of river Morača (Morača, Zeta and Cijevna) and Lake Rikavačko” financed by the Government of Montenegro-Ministry of Agriculture, Forestry and Water Management.

REFERENCES

- Bagenal, T.B. & Tesch, F.W. (1978). Age nad growth. In: T. B. Bagenal (Ed) Methods for the assessment of fish production in fresh waters. Blackwell Scientific Publication, Oxford, pp. 101-136.
- Burić, M. (2010). Atlas of waters of Montenegro, Izdanja Leksikografskog centra, 1, Crnogorska akademija nauka i umjetnosti, Podgorica.

- Drecun, Đ., Knežević, B., Filipović, S., Petković, S., Petković, St. & Nedić, D. (1985). Biološko-ribarstvena istraživanja rijeke Morače, njenih pritoka i Rikavačkog jezera (Lymnological researches of the Morača river basin, and the Rikavačko Lake), Agrosaznanje, 4: 1-92. In Serbian
- Froese, R. & Pauly, D. (2014). FishBase. World Wide Web electronic publication. Available at: <http://www.Fishbase.org> (accessed on 04.2015)
- Froese, R. (2006): Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendation. *Journal of Applied Ichthyology* 22, 241-253.
- Gutreuter, S. & Krzoska, D.J. (1994). Quantifying precision of in situ length and weight measurements of fish. *North American Journal of Fisheries Management*, 14: 318-322.
- Hrvačević, S. (2004). Resource of surface water in Montenegro. 331 pp.
- Jordanova, M., Hristovski, S., Rebok, K., Musai, M., Dinevska-Kovkakovska, S. & Melovski, Lj. (2020). *Macedonian Journal of Ecology and Environment*, 22 (2): 107-109.
- King M. 2007. Fisheries biology, assessment and management. Second Edition. Blackwell Scientific Publications, Oxford.
- Krivokapić, M. (1992). Ishrana endemične podvrste jelšovke *Leuciscus souffia montenegrinus* (Vuković, 1963) iz rijeke Morače. *Glasnik republičkog zavoda za zaštitu prirode – Prirodnjačkog muzeja*, 25: 83-91.
- Krivokapić, M. (1998): Growth of *Telestes montenegrinus* from River Morača, Montenegro (Cyprinidae). *Italian Journal Zoology*, 65 suppl.: 241-242.
- Krivokapić, M. (2002 a): Mriješćenje podvrste *Leuciscus souffia montenegrinus* (Cyprinidae, Pisces) iz rijeke Morače. *Natura montenegrina*, 1: 153-158.
- Krivokapić, M. (2002): Biološka proučavanja endema sliva Skadarskog jezera – *Leuciscus souffia montenegrinus* (Osteichthyes, Cyprinidae) – meristički parametric. *Natura montenegrina*, 1: 135-152.
- Krivokapić, M. (2003 a): Biologija razmnožavanja *Leuciscus souffia montenegrinus* (Pisces, Cyprinidae) iz rijeke Morače. *Natura montenegrina*, 2: 71-77.
- Krivokapić, M. (2003): Morfološka analiza karakteristika krljušti moračke jelšovke (*Leuciscus souffia montenegrinus*). *Natura montenegrina*, 2: 62-70.
- Marić, D. (2019): Fauna of freshwater fish (Osteichthyes) of Montenegro. Montenegrin academy of science and art. Special editions (Monographies and Studies). Volume 149. 419 p. ISBN: 978-86-7215-453-5
- Marić, D. & Milošević, D. (2011): Catalog of freshwater fishes (Osteichthyes) of Montenegro. Montenegrin academy of Sciences and arts. Volume 5, Book 4. Podgorica. pp 114.
- Marić, D. & Rakočević, J. (2015). Some life-history traits of Adriatic brown trout *Salmo farioides*, Karaman 1938 (Salmonidae) from the Morača River (Montenegro). *Acta Zoologica Bulgarica*, 67 (2): 249-257.
- Marić, D., Burzanović, K., Marić, S. (2022). Variability of length weight relationship and condition factor of the European eel (*Anguilla anguilla* L.) – case study from the Lake Skadar (Montenegro). *Agriculture and Forestry*, 68 (2): 175-191. doi:10.17707/AgricultForest.68.2.13
- Marić, S., Rakočević, J. & Marić, D. (2010): Diversity and distribution of species from genus *Barbus* in waters of Montenegro. *Natura Montenegrina* 9 (2): 169-182.
- Milošević, D. and Mrdak, D. (2016). Length-weight relationship of nine fish species from Skadar Lake (Adriatic catchment area of Montenegro). *Journal of Applied Ichthyology* 32: 1331–1333

- Milošević, D. and Talevski, T. (2016). Length-weight relationship of 11 fish species from great natural and two artificial lakes in the Former Yugoslav Republic of Macedonia (FYROM). *Acta Zoologica bulgarica* 68 (3) : 391-394
- Ricker, W.E. (1975): Computation and interpretation of biological statistics of fish populations. *Bulletin Fisheries Research Board of Canada*, 191, 1-382.
- Wootton, R.J. (1990): *Ecology of teleost fishes*. Chapman & Hall, London, pp.404