

ECOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS OF THE DANUBE CRAYFISH *PONTASTACUS LEPTODACTYLUS* (ESCHSCHOLTZ, 1823) FROM THE MATURA RIVER (BOSNIA AND HERZEGOVINA)

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Abstract

Danube crayfish, one of the native European crayfish species, is on decline in many parts of its range. The Sava River and its tributaries are under increased pressure from invasive crayfish spreading. Providing data on resident native crayfish species is thus of utmost importance for their better conservation and protection. The population of *Pontastacus leptodactylus* (Eschscholtz, 1823) from a small tributary of the Sava River, The Matura River, has been investigated from May to August 2021. Our research encompassed a sample of 54 adult *P. leptodactylus* specimens (31 males and 23 females). Crayfish were sampled, measured and released unharmed. A standardized set of 12 morphometric parameters as well as body weight were taken. Positive correlation was found between body length and weight ($\sigma^2 R^2=0.9111$; $\text{♀ } R^2=0.9116$), body weight and claws length ($\sigma^2 R^2=0.8923$; $\text{♀ } R^2=0.9596$), as well as carapace width and body length ($\sigma^2 R^2=0.9761$; $\text{♀ } R^2=0.8838$). Pronounced sexual dimorphism regarding most of the measured parameters was confirmed. Fulton's condition factor and the Crayfish constant both indicate males are in better fitness, which is in line with the results of previous research in Europe. Apart from crayfish data, the main physical and chemical parameters of the habitat and present aquatic macroinvertebrates community were measured as complementary data. Moderate level of organic pollution is present, with N and P (nitrogen and phosphorus) being the main threats, mostly due to intensive agriculture in the area. The macroinvertebrates community consists of 14 identified taxa, with gastropods as the most diverse and abundant group (57%). Crustaceans (Amphipoda and Isopoda) are the subdominant group in terms of relative abundance (30%). The recorded macroinvertebrate community indicates moderate organic pollution, and it is quite typical for similar watercourses in the region.

Key words: crayfish, fitness, morphometric characteristics, Matura River, Bosnia and Herzegovina

INTRODUCTION

The first scientific research on crayfishes in BiH is found in the works of Entz (1914), Karaman (1929), Karaman (1961, 1962, 1963) and Albrecht (1982). Since then, crayfishes have been the subject of zoological research and have often been used in environmental studies (Trožić-Borovac, 2011). Crayfishes belong to the largest mobile, freshwater invertebrates and are bioindicators of water quality (Parks *et al.*, 1991). Crayfishes are a significant component of biodiversity in streams, rivers and lakes, with an important ecological role in the proper functioning of freshwater ecosystems (Holdich, 2002) and a key role in food chains (Nyström *et al.*, 1996).

The Danube crayfish species is characterized by high phenotypic plasticity, which results in a high density of its population (Bolat *et al.*, 2011), and this species also shows significant geographical variation in diet (Šidagytė *et al.*, 2017) and reproductive biology (Skurdal and Taugbøl, 2002) which makes it very suitable for morphological as well as for population and ecological research.

Data on the values of morphometric characters, ecology and zoogeography of the Danube crayfish *Pontastacus leptodactylus* from different geographical areas within their areal are very scarce and incomplete (Holdich *et al.*, 2009; Śmietana *et al.*, 2006). It is a widespread European species (Holdich, 2002), present in eastern Russia and the Middle East. However, it is not present in Norway and Sweden, or in Spain and Portugal (Souty-Grosset *et al.*, 2006). During the last 100 years, this species was introduced to many European countries primarily as a commercially valuable species to recover from the loss of the vanished populations of the noble crayfish, *Astacus astacus* (Linnaeus, 1758), affected by the crayfish plague, despite the fact that *P. leptodactylus* is also susceptible to this disease (Bláha *et al.*, 2023).

Danube crayfish inhabit lowland rivers, lakes, estuaries and brackish waters and react well to the eutrophic conditions prevailing in the habitat: warmer waters (up to 32 °C), small amounts of oxygen and muddy bottoms (Holdich, 2002; Maguire, 2010, Gherardi and Souty-Grosset, 2017). A review of the above literature established the presence of *P. leptodactylus* in Bosnia and Herzegovina (Trožić-Borovac, 2011) and Republika Srpska (Roljić *et al.*, 2019), as well as in the surrounding countries, Serbia (Simić *et al.*, 2008) and Croatia (Maguire and Gottstein-Matočec, 2004).

The Danube crayfish is the strongest autochthonous European crayfish species that shows certain invasive characteristics. Recent studies have shown its spread to new habitats previously inhabited by the river crayfish species *A. astacus* (Maguire *et al.*, 2011), and also as a result of its extinction due to the spread of allochthonous species.

Although *P. leptodactylus* shows certain invasive characteristics (Holdich *et al.*, 2009; Hudina *et al.*, 2016; Perdikaris and Georgiadis, 2017), it is endangered due to the spread of allochthonous American crayfish (*Pacifastacus leniusculus* and *Faxonius limosus*) that are carriers of crayfish plague, to which they are resistant, but it is fatal to European crayfishes including *P. leptodactylus* (Alderman, 1996; Hatcher *et al.*, 2012). The authors Hudina *et al.* (2016) point to the fact that we can expect its further slow disappearance in contact zones with allochthonous American species of crayfish. Also, water pollution, watercourse regulation and removal of vegetation along the coast, as well as the consequences of extreme droughts,

strongly affect the diversity and distribution of *P. leptodactylus* population. Insight into historical and recent data, Gherardi and Souty-Grosset (2017) found that Danube crayfish has suffered significant declines both in the past and today, but most populations appear to be relatively stable.

Data on this species are of great importance and are necessary for determining the state of populations and future protection measures, bearing in mind that this is a species that is in the Regulation on strictly protected and protected wild species (Official Gazette of the Republic of Srpska, 65/20). Once preliminary studies have established the presence of this species in the Matura River (Roljić *et al.*, 2019; Roljić, 2023), our intention was to look at the general abiotic and biotic conditions in which this species exists. Also, our goal is to examine the variation in basic morphometric characters and their relationship with general ecological conditions as well as to determine the degree of fitness of the sampled individuals.

MATERIALS AND METHODS

For consideration of ecological characteristics of Danube crayfish, physical and chemical parameters in the water of the Matura River, the qualitative and quantitative composition of macrozoobenthos and morphological characteristics of the sampled crayfish were analyzed. Field research was conducted from May to August 2021, and the sampling period included two seasonal activities of crayfishes: spring and summer. Sampling was performed in the Matura River (locality: Srbac, 45.12330 ° N, 17.43471 ° E, 90 m a.s.l.).

At the studied site, we recorded GPS coordinates and elevation. In situ, the air temperature, water temperature, pH value, electrical conductivity, and dissolved oxygen were measured. Under laboratory conditions, the following parameters were measured: alkalinity as CaCO₃, total hardness as CaCO₃, total suspended solids, oxygen saturation in water, BOD₅, total nitrogen (N_{inorganic} + N_{organic}), and total phosphorus. Laboratory analyses were performed at the Institute of Public Health of the Republic of Srpska.

Macrozoobenthos samples were collected with Surber net, with a catchment area of 0.1 m² and mesh size of 350 µm. Individuals were stored in tubes containing 70% ethanol for later taxa identification. In the laboratory, samples were analyzed using a stereomicroscope (Leica EZ4D at 35× magnification). Macroinvertebrates were identified using identification key by Kriska (2013).

LiNi traps with bait were used to collect Danube crayfish (Westman *et al.*, 1978). To avoid comparing juvenile and adult crayfish, animals with a total body length of less than 60 mm were excluded from further analysis. Crayfish sampling was performed at night, in the period from 8:00 p.m. to 08:00 a.m. On that occasion, 54 individuals of the Danube crayfish were caught. For each caught individual, sex and weight were determined, and their morphometric characteristics were measured. Sex is determined macroscopically, based on the presence or absence of gonopods. The following morphometric characteristics have been analyzed according to Sint *et al.* (2007): total body length (TL), claws length (CLL), claws width (CLW), rostrum length (ROL), rostrum width (ROW), carapace length (CL), carapace width (CPW), abdominal length (ABL), the width of the first abdominal pleura (ABW), telson

length (TEL), telson width (TEW) and in addition to these parameters, body weight values (W) were measured (Figure 1). Length values are expressed in millimeters, and body mass in grams.

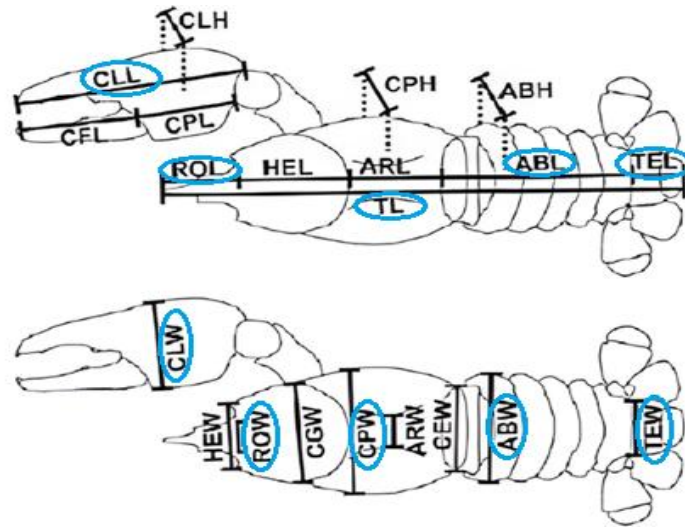


Figure 1. Measured characteristics (circled in blue) and the position of reference points on the body of freshwater crayfish from Astacidae family (according to Sint *et al.*, 2007)

The parameters are determined by the values of body weight (W), Fulton's condition factor (FCF) and Decapoda crayfish (CC) constants.

Fulton's Conditions Factor (FCF):

$$FCF = \frac{W}{TL^3}$$

Where: W – total weight, TL – total length

Crayfish Constant (CC):

$$CC = \frac{W}{TL \times CPL \times CPW}$$

Where: W – total weight, TL – total length, CL – carapace length, CPW – carapace width (Streissl and Höld, 2002).

We used "Kern" scales (Kern PFB Version 2.2; Kern EW 600-C3NM) to determine the mass, and morphometric measurements were performed using a caliper. Measured values of morphometric characteristics were processed statistically (minimum, maximum, mean values, standard deviation and coefficient of variation) using the STATISTICA 6.0 software. Additionally, a T-test (confidence level of $p < 0.05$) and Chi-square test were performed to assess the significance of differences between groups and the distribution of categorical variables, respectively. The results of these analyses were interpreted and compared with available literature data.

After the measures were recorded, the crayfishes were released at the site where they were sampled. No specimens were injured or displaced from the habitat where they were found during the field work.

RESULTS

Physical and chemical parameters

Table 1 shows the results of the physicochemical parameters of the water. The classification of the water is determined in accordance with the Regulation on water classification and categorization of watercourses (Official Gazette of the Republic of Srpska, 42/01), which was applied at the time of processing these data.

Table 1. Values of physical and chemical parameters of water from the Matura River

Examined parameter	Method	Measured values	Watercourse class
Air temperature (°C)	UMHH26	21	
Water temperature (°C)	SMEWW 22th 255 B	21	
Dissolved oxygen (g/m ⁻³)	BAS EN ISO 5841:2014	5.7	III
% oxygen saturation	UMH 416	64.5	III
pH	BAS ISO 10523:2013	7.97	I
Conductivity (µScm ⁻¹)	BAS EN 27 888:2002	629	III
BOD ₅ (gO ₂ /m ⁻³)	BAS ISO 5815-2:2004	1.0	I
Alkalinity as CaCO ₃ (g/m ⁻³)	BAS EN ISO 9963- 1:2000	315.5	I
Total hardness as CaCO ₃ (g/m ⁻³)	BAS ISO 6059:2000	366.0	I
Suspended matter (g/m ⁻³)	BAS ISO 11923:2002	2.5	II
Total nitrogen (N _{inor} + N _{org.}) (gN/m ⁻³)	SMEWW 22 nd 4500-NO ₂ ⁻ B:2012; SMEWW 22 nd 4500-NO ₃ ⁻ B:2012; BAS EN 25663:2000	6.6	III
Total phosphorus (gP/m ⁻³)	SMEWW22 nd 4500-PE:2012	0.028	II

Macroinvertebrate community

During the study of the composition of macrozoobenthos in the Matura River, 14 taxa in total were collected from 6 taxonomic-ecology groups (Gastropoda, Oligochaeta, Hirudinea, Crustacea, Lepidoptera and Trichoptera). Of the total number of taxa, nine taxa were identified up to the species level, two taxa were identified up to the genus level, and also, two taxa were identified up to the family level, whereas individuals from the class Hirudinea were not identified to a lower taxonomic level. The list of identified taxa of macrozoobenthos is shown in Table 2.

Table 2. Qualitative-quantitative macrozoobenthos composition of the Matura River

TAXON	%
GASTROPODA	
Bithyniidae	
<i>Bithynia tentaculata</i> (Linnaeus, 1758)	13.63
Melanopsidae	
<i>Esperiana esperi</i> (Ferussac, 1823)	11.36
<i>Microcolpia daudebartii</i> (Prevost, 1821)	13.63

<i>Holandriana holandrii</i> Pfeiffer, 1828	4.55
Neritidae	
<i>Theodoxus danubialis</i> (C. Pfeiffer, 1828)	2.27
<i>Theodoxus fluviatilis</i> (Linnaeus, 1758)	4.55
Planorbidae	
<i>Planorbis planorbis</i> (Linnaeus, 1758)	4.55
Viviparidae	
<i>Viviparus</i> sp.	2.27
OLIGOCHAETA	
<i>Eiseniella tetraedra</i> (Savigny, 1826)	4.55
HIRUDINEA	2.27
CRUSTACEA	
Asellidae	
<i>Asellus aquaticus</i> (Linnaeus, 1758)	6.82
Gammaridae	
<i>Gammarus</i> sp.	22.73
INSECTA	
Lepidoptera	
Pyralidae/Crambidae	4.55
Trichoptera	
Polycentropodidae	2.27

Morphometric parameters of Danube crayfish with the condition indices

Within 54 analyzed specimens it was found that 31 (or 57.41%) were males, and 23 (or 42.59%) were females (sex ratio close to 1.35:1).

Measurement results of morphometric parameters of Danube crayfish specimens from the Matura River are presented in tables as mean value, minimum, maximum, standard deviation and variation coefficient. The results are shown separately for males and females (Table 3).

Table 3. Descriptive statistics of measured morphometric characteristics for *P. leptodactylus* from the Matura River, by sex (Min – minimum value, Max – maximum value, SD - standard deviation, CV – coefficient of variation)

Morphometric parameter	Male (n=31)					Female (n=23)				
	Mean	Min	Max	SD	CV	Mean	Min	Max	SD	CV
TL	98.65	68.03	133.7	17.10	17.33	92.72	62.2	120.12	17.43	18.80
W	24.12	10.10	55.6	12.95	53.69	24.18	11	49.80	12.92	53.43
CLL	36.07	20.22	71.36	10.34	28.67	34.77	13.20	62.30	14.40	41.42
CLW	14.49	5.53	34.44	5.11	35.27	11.40	5.40	24.54	4.26	37.37
ROL	17.69	10.40	22.62	3.41	19.28	13.73	9.25	17.28	2.50	18.21
ROW	7.70	4.97	11.54	2.20	28.57	7.37	5.06	10.20	1.85	25.10
CL	53.48	42.70	67.34	7.41	13.86	38.03	30.14	47.79	6.34	16.67
CPW	26.43	15.88	36.29	5.17	19.56	25.06	15.34	37.71	5.66	22.59
ABL	37.26	20.73	67.27	9.15	24.56	30.76	21.18	47.95	7.01	22.79
ABW	21.71	14.2	33.6	5.13	23.63	25.32	13.74	36.36	6.17	24.37
TEL	16.24	11.40	19.60	2.48	15.27	13.11	9.36	16.89	2.28	17.39

TEW	15.31	10.00	20.21	3.07	20.05	11.75	8.72	14.70	1.80	15.32
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Using the t-test, a statistically significant difference of the analyzed morphometric parameters was found between the sexes (Table 4), which is explained by the pronounced sexual dimorphism of Danube crayfish.

Table 4. Significance of differences between mean values of morphometric characteristics of crayfish species *P. leptodactylus* from the Matura River (p - level of significance: bold values indicate $p < 0.05$)

Morphometric parameter	t - value	p
TL	1.251244	0.216446
W	-0.016544	0.986864
CLL	0.385627	0.701346
CLW	2.358308	0.022153
ROL	3.281123	0.002625
ROW	0.413891	0.681898
CL	5.670087	0.000004
CPW	0.922704	0.360423
ABL	2.837271	0.006472
ABW	2.277223	0.026915
TEL	3.407206	0.001836
TEW	3.407864	0.001833

Table 5. Descriptive statistics and estimated parameters of weight-length and biometric relationships for both sexes of *P. leptodactylus* from the Matura River (TL- total length; W- weight; CLL-chela length; CPW-carapace width)

Relation		Sex	
		M	F
TL/W	y	$0.723x^{-47.209}$	$0.7078x^{-41.445}$
	R^2	0.9111	0.9116
	Correl.	91.11	91.16
W/CLL	y	$0.7539x^{+17.884}$	$1.0919x^{+8.3719}$
	R^2	0.8923	0.9596
	Correl.	89.23	95.96
CPW/TL	y	$0.2986x^{-3.0328}$	$0.3052x^{-3.2352}$
	R^2	0.9761	0.8838
	Correl.	97.61	88.38

The lowest Crayfish Constant (CC) is 0.146 (for females) and the highest 0.288 (for males). The mean value for females is 0.163 and for males 0.263. The least Fulton's Conditions Factor (FCF) is 0.019 (for females), and the largest is 0.030 (for males). The mean value for males is 0.027 and for females 0.023 (Table 6).

Table 6. Values for condition factor for *P. leptodactylus* specimen (FCF- Fulton's Conditions Factor, CC- Crayfish Constant)

FCF					
Sex	Mean	Min	Max	SD	CV
M	0.027	0.023	0.030	0.002	7.41
F	0.023	0.019	0.027	0.002	8.70
CC					
Sex	Mean	Min	Max	SD	CV
M	0.263	0.230	0.288	0.018	6.84
F	0.163	0.146	0.175	0.009	5.52

DISCUSSION

The Matura River is exposed to the effects of a variety of anthropogenic kinds of impact, and is under influence of agricultural activities primarily. Low values of oxygen saturation in water, dissolved oxygen, and increased values of total nitrogen and electrical resistivity classify the Matura River into the III class of surface water. Based on the total values of concentrations of total suspended matters and total phosphorus, the Matura River belongs to the II class, while all other parameters meet the I class requirements according to the Regulation on water classification and categorization of watercourses (Official Gazette of the Republic of Srpska, 42/01). Increased values of total nitrogen (Ninorg+Norg) and total phosphorus result from water pollution, primarily by washing the surrounding soil where various agrotechnical measures are implemented.

The macroinvertebrate community consists of 14 identified taxa, with gastropods being the most diverse and numerous group (8 taxa, 57% of all specimens collected). Crustaceans (Amphipoda and Isopoda) are the subdominant group in terms of relative abundance (30%).

The first studies on the biogeography and taxonomy of freshwater crayfish were based on morphometric characteristics (Entz, 1914; Karaman, 1929; Karaman, 1961, 1962, 1963; Albrecht, 1982; Trožić-Borovac *et al.*, 2007; Šanda and Petrusek, 2008; Trožić-Borovac, 2011). Morphometric studies are often used in studies of intraspecific and interspecific variability in freshwater crayfish (Sint *et al.*, 2005). Individuals of the narrow-clawed crayfish can reach 30 cm TL, but they are generally less than 15 cm TL (Kouba *et al.*, 2015, Erol *et al.*, 2021). In general, morphological differences between individuals of the same species may occur as a result of genetic differences (Hidayani *et al.*, 2018) or environmental factors (Yampolsky *et al.*, 2014) and their interactions (Berger *et al.*, 2018). Research conducted by Rajković (2012) and Đuretanić (2019) has shown that analyses of a large number of morphometric characters per individual are a good method for separating groups of decapods, which could not be achieved by analyzing only a few morphometric characters.

Multivariate analyses of morphometric parameters play a key role in biology, allowing researchers to simultaneously analyze multiple variables and explore relationships among them (Rencher, 2002). These methods enable the identification of patterns and differences among populations, which can be useful for studying evolutionary processes, adaptations, and species ecology. The application of multivariate analyses can be seen in the investigation of shape and

size variability in organisms, as well as in assessing the impact of environmental factors on morphological characteristics (Marhold, 2011). Additionally, these analyses aid in species classification and understanding biological diversity, which is essential for conservation efforts.

The analysis was carried out on 54 individuals of Danube crayfish from the Matura to determine whether there were statistically significant differences between them. 12 morphological characteristics per individual of Danube crayfish were analyzed in detail.

The sex ratio in the sample of 54 individuals was shifted in favor of males and amounted to 1.35: 1. This value significantly differs from the theoretical 1:1 value ($\chi^2 = 1.19$, $p = 0.28$). Insight into the sex ratio in the population is of great importance, because only a balanced sex ratio is a sign of a healthy and stable population (Jurković, 2016). An unbalanced sex ratio can be due to biased sampling (Deniz *et al.*, 2010), but also to various biological factors, such as an unequal sex ratio after hatching, differential immigration and emigration of individuals of different sexes. The inequality between the sexes may also be the result of differences in activity between the different sexes (Dakić and Maguire, 2016), the different age of reaching sexual maturity, but also the different life spans of individuals of different sexes.

The population of Danube crayfish at the investigated locality has a relatively stable age structure. The most represented was a group of individuals with a body length of 80 - 120 mm with 73.58%. The longest male had 133.7 mm and the longest female 120.12 mm which is in line with the values recorded by Deniz *et al.* (2010) and Roljić *et al.* (2019). The heaviest male weighed 55.6 g and the heaviest female's weight was 49.8 g. The higher values for weight of males can be attributed to the fact that males have larger claws which contributes to their body weight compared to females (Rajković, 2012). By analyzing the analyzed morphometric parameters, a significant positive correlation was observed between total body length and weight, as well as between body mass and claw length, and also between body length and carapace width. These observations are consistent with other studies conducted on different freshwater decapod crustaceans (Rajković, 2012; Roljić, 2023). When it comes to the sexual structure, the sampled individuals of the species *P. leptodactylus* were below and above the limits of sexual maturity. Males and females of this species usually reach sexual maturity in the second or third year of life, when their total length is 75-85 mm (Holdich, 2002).

Presence of sexual dimorphism, with males being larger (with larger body parts) could be explained by allometric growth of adult individuals (Deniz, 2010). Numerous are studies where it was confirmed (Grandjean *et al.*, 1997; Grandjean and Souty-Grosset 2000; Sint *et al.*, 2005, 2006, 2007; Trožić-Borovac *et al.*, 2007; Maguire and Dakić, 2011; Rajković, 2012; Đuretanić, 2019). Our results with body weight, width of the first abdominal pleura (ABW) and length and width of the right claws (CLL, CLW) as the main sexual dimorphic characters are in accordance with research conducted by Maguire (2002).

According to the values of the calculated indices (CC, FCF), it is evident that crayfish are in rather good condition. Research conducted by Streissl and Hödl (2002) on freshwater decapod crayfish revealed an association between crayfish body condition and habitat characteristics. Namely a greater diversity of water-flow and more diverse bottom substrate have positive effect on the condition of crayfish. If we take into account the characteristics of the investigated locality which has diverse crayfish shelters, it is not surprising analyzed

crayfish have fairly good condition. It could be noted as well that males are in better condition, which is in line with the findings of the study by Roljić *et al.* (2019). Furthermore, according to the proposal of Streissl and Hödl (2002), it is possible that this difference is caused by larger claws in males compared to females. This was also confirmed in *Astacus astacus* (Trožić-Borovac *et al.*, 2012), *Austropotamobius torrentium* (Trožić-Borovac *et al.*, 2007) and *A. pallipes* (Trožić-Borovac, 2012).

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EKOLOŠKE I MORFOLOŠKE KARAKTERISTIKE DUNAVSKOG RAKA *PONTASTACUS LEPTODACTYLUS* (ESCHSCHOLTZ, 1823) IZ RIJEKE MATURE (BOSNA I HERCEGOVINA)

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Sažetak

Dunavski rak, jedna od autohtonih evropskih vrsta rakova, bilježi pad populacije u mnogim dijelovima svog areala. Rijeka Sava i njene pritoke su pod sve većim pritiskom širenja invazivnih vrsta rakova. Stoga je pružanje podataka o autohtonim vrstama rakova od najveće važnosti za njihovu bolju zaštitu i očuvanje. Populacija vrste *Pontastacus leptodactylus* (Eschscholtz, 1823) iz male pritoke rijeke Save, rijeke Mature, istraživana je od maja do

avgusta 2021. godine. Naše istraživanje obuhvatilo je uzorak od 54 odrasla primjerka *P. leptodactylus* (31 mužjak i 23 ženke). Rakovi su prikupljeni, izmjereni i pušteni nazad u prirodu bez povreda. Standardizovani set od 12 morfometrijskih parametara, kao i tjelesna masa, su izmjereni. Pronađena je pozitivna korelacija između dužine tijela i mase (♂ $R^2=0,9111$; ♀ $R^2=0,9116$), mase tijela i dužine kliješta (♂ $R^2=0,8923$; ♀ $R^2=0,9596$), kao i širine karapaksa i dužine tijela (♂ $R^2=0,9761$; ♀ $R^2=0,8838$). Izražen seksualni dimorfizam je potvrđen za većinu mjerenih parametara. Vrijednosti Fultonovog koeficijenta kondicije i konstante za rakove pokazuju da su mužjaci u boljem kondicionom stanju, što je u skladu sa rezultatima prethodnih istraživanja u Evropi. Pored podataka o rakovima, mjereni su i analizirani i osnovni fizičko-hemijski parametri staništ, kao i zajednica prisutnih vodenih makrobescičmenjaka. Prisutan je umjeren nivo organskog zagađenja, sa azotom i fosforom kao glavnim prijetnjama, uglavnom zbog intenzivne poljoprivrede u tom području. Zajednica makrobescičmenjaka se sastoji od 14 identifikovanih taksona, pri čemu su puževi najraznovrsnija i najbrojnija grupa (57%). Rakovi (Amphipoda i Isopoda) su poddominantna grupa u pogledu relativne brojnosti (30%). Zabilježena zajednica makrobescičmenjaka ukazuje na umjereno organsko zagađenje i tipična je za slične vodotokove u regionu.

Ključne riječi: rakovi, fitness, morfometrijske karakteristike, rijeka Matura, Bosna i Hercegovina

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