

A contribution to the knowledge of the sexual size dimorphism of the narrow-clawed crayfish (*Pontastacus leptodactylus* Eschscholtz, 1823) from Bulgaria

IVELIN MOLLOV

University of Plovdiv “Paisii Hilendarski”, Faculty of Biology, Department of Ecology and Environmental Conservation, 24 Tzar Assen Str., Plovdiv, BG-4000 Bulgaria, mollov_i@uni-plovdiv.bg

Abstract. This study examines the sexual size dimorphism in 20 adult *Pontastacus leptodactylus* from “Kardzhali” Dam Lake, Bulgaria, via 15 morphometric traits. Mann-Whitney U-tests reveal significant differences in 19 parameters: males exhibit larger carapaces and chelae (e.g., chela length SDI 42.5%), while females have wider abdomens and telsons, aligning with previous studies. The results contribute to the data on phenotypic plasticity and conservation needs, considering the scarce regional data. The present study could provide additional information for future studies and management plans.

Key-words: morphometrics, *Pontastacus leptodactylus*, Bulgaria.

Introduction

The narrow-clawed crayfish (*Pontastacus leptodactylus* Eschscholtz, 1823) is widespread throughout Europe, eastern Russia, and the Middle East. The species shows well-expressed phenotypic variability enabling it to inhabit various habitats - lowland and slow-flowing rivers with soft muddy bottom, estuaries, lakes, ponds, brackish waters and swamps (Vasileva *et al.* 2017; Roljić *et al.* 2019).

In Bulgaria, the studies on the exterior characteristics of the narrow-clawed crayfish are scarce. Sexual dimorphism of the species from the natural population from “Kardzhali” Dam Lake was studied by Vasileva *et al.* (2005). Another study from the same authors researched the morphometric variability and sexual dimorphism of narrow-clawed crayfish, cultivated at the Institute of Fisheries and Aquaculture in Plovdiv City (Vasileva *et al.* 2017).

This study aims to contribute to the knowledge of the sexual size dimorphism in *P. leptodactylus* and determine whether there are differences in some basic morphometric characteristics of males and females.

Material and Methods

The analysed material is 20 adult specimens (10 males and 10 females) from approximately the same size group, collected in 2007 from Kardzhali Dam Lake (fish case base at Enchevtsi Village). The material was collected and all individuals were determined and sexed by Assoc. Prof. Angel Tsekov, PhD and the data (previously unpublished) kept in the Department of Ecology and Environmental Conservation, Faculty of Biology at the University of Plovdiv “Paisii Hilendarski”.

Morphological characteristics were measured, using digital calipers (0.01 mm accuracy) on specimens of different age, but from approximately the same size group, from the same location. Fifteen body parameters were measured and analysed following the scheme used by Vasileva *et al.* (2017), shown on Fig. 1.

The sexual size dimorphism index (SDI) was calculated using the formula provided by Lovich & Gibbons (1992) - $SDI = (\text{parameter of the larger sex} / \text{parameter of the smaller sex}) - 1 \cdot 100$. Data from previous studies (Vasileva *et al.* 2005; 2017; Roljić *et al.* 2019) show that the males are usually bigger than females, so in this study for calculating the SDI the males are chosen as the larger sex. The results were statistically processed using descriptive statistics and the Mann-Whitney U-test (since the data did not have normal distribution), using the software package "PAST" ver. 5.2 (Hammer *et al.* 2001).

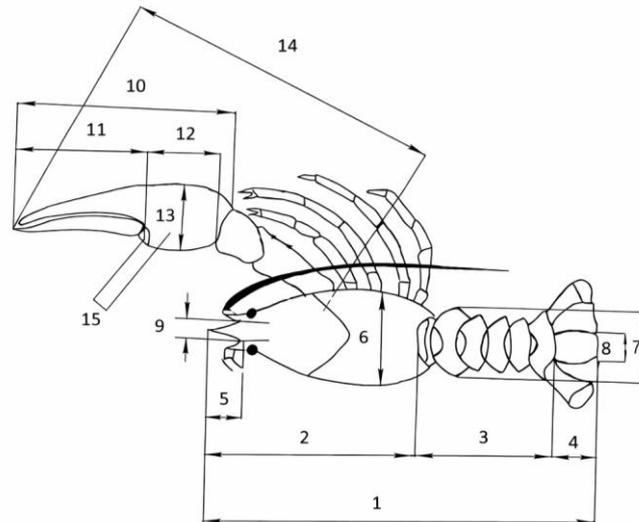


Fig. 1. Morphological parameters of the narrow-clawed crayfish (*P. leptodactylus* Eschscholtz, 1823). Legend: 1 - total body length, 2 - carapace length, 3 - abdomen length, 4 - telson length, 5 - rostrum length, 6 - carapace width, 7 - abdomen width, 8 - telson width, 9 - rostrum width, 10 - chela length, 11 - dactyl length, 12 - palm length, 13 - chela width, 14 - chelae length from its carpal joint to its tip, 15 - chela corpulence (after Vasileva *et al.* 2017).

Results and Discussion

The measured morphometric parameters of *P. leptodactylus*, taken in the current study are presented in Table 1 and Fig. 2.

The results show statistically significant differences on 9 morphometric parameters. The carapace width, chela length, dactyl length, palm length, chela width, chelae length from its carpal joint to its tip and chela corpulence are statistically significantly bigger in males, while the abdomen width and telson width are statistically significantly bigger in females.

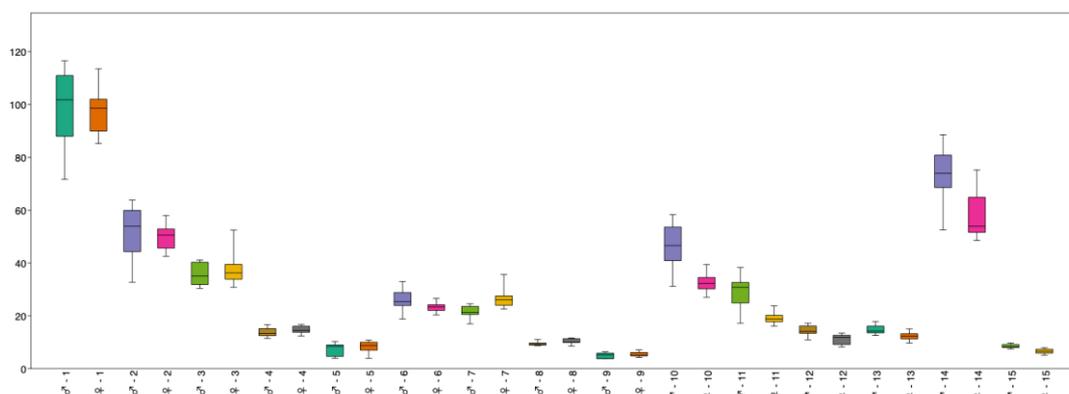


Fig. 2. Box & whiskers plot of the measured 15 morphological parameters in males and females individuals of the narrow-clawed crayfish (*P. leptodactylus*). Legend: (see Fig. 1).

Table 1. Descriptive statistics of the studied 15 morphometric measurements of *P. leptodactylus* (see Fig. 1). *Legend:* M – males, F – females, SD – standard deviation, standard error, * - statistically significant differences at $p \leq 0.05$, ** - statistically significant differences at $p \leq 0.01$, *** - statistically significant differences at $p \leq 0.001$, SDI – sexual size dimorphism index.

Morpho-metric parameter	Sex	Mean	SD	SE	Mann-Whitney U-test	SDI, %
1	M	98.39	14.27	4.51	U=45.00, z=0.34, p=0.73	0.73
	F	97.67	8.38	2.65		
	M+F	98.02	11.40	2.55		
2	M	51.42	9.75	3.08	U=38.00, z=0.87, p=0.38	3.17
	F	49.84	4.68	1.48		
	M+F	50.63	7.49	1.67		
3	M	35.54	4.06	1.28	U=41.50, z=0.60, p=0.54	-5.18
	F	37.48	5.99	1.89		
	M+F	36.51	5.08	1.14		
4	M	13.67	1.60	0.50	U=30.00, z=1.47, p=0.14	-6.88
	F	14.68	1.36	0.43		
	M+F	14.18	1.54	0.34		
5	M	7.18	2.37	0.75	U=35.00, z=1.10, p=0.27	-13.91
	F	8.34	2.10	0.66		
	M+F	7.76	2.62	0.51		
6	M	25.99	3.89	1.23	U=21.00, z=2.15, p=0.03*	12.02
	F	23.20	1.72	0.54		
	M+F	24.60	3.26	0.73		
7	M	21.55	2.25	0.71	U=8.00, z=3.14, p=0.002**	-18.95
	F	26.59	3.62	1.14		
	M+F	24.10	3.91	0.87		
8	M	9.37	0.71	0.22	U=21.00, z=2.15, p=0.03*	-9.20
	F	10.32	0.95	0.30		
	M+F	9.85	0.95	0.21		
9	M	4.94	1.05	0.33	U=43.50, z=0.45, p=0.65	-6.79
	F	5.30	0.88	0.28		
	M+F	5.12	0.96	0.21		
10	M	46.37	8.33	2.63	U=7.00, z=3.21, p=0.001***	42.50
	F	32.54	3.35	1.06		
	M+F	39.45	9.41	2.10		
11	M	29.11	6.16	1.95	U=9.00, z=3.06, p=0.002**	52.49
	F	19.09	2.11	0.67		
	M+F	24.10	6.82	1.52		
12	M	14.35	1.84	0.58	U=8.50, z=3.10, p=0.002**	28.12
	F	11.20	1.89	0.60		
	M+F	12.78	2.43	0.54		
13	M	14.72	1.67	0.53	U=10.00, z=2.98, p=0.003**	21.05
	F	12.16	1.56	0.49		
	M+F	13.44	2.05	0.46		
14	M	73.45	9.89	3.13	U=10.00, z=2.98, p=0.003**	27.80
	F	57.47	8.46	2.67		
	M+F	65.46	12.14	2.71		
15	M	8.50	0.74	0.23	U=2.00, z=3.59, p=0.0003***	29.97
	F	6.54	0.88	0.28		
	M+F	7.52	1.28	0.29		

These results concur previous Bulgarian studies on the same population (Vasileva *et al.* 2005) and aquaculture samples (Vasileva *et al.* 2017), confirming male-biased chela dimorphism, which likely aids in mate competition or agonistic behavior, while larger female-biased abdomen supports egg brooding. These patterns suggest phenotypic plasticity in *P. leptodactylus*, as chela dimorphism varies across habitats: stronger in Kardzhali Dam's eutrophic, muddy-bottom reservoir (current SDI chela=42.5%) versus rivers like Vrbas (Roljić *et al.* 2019). Kardzhali Reservoir, formed in 1987 on the Arda River, features soft sediments from mining and agricultural runoff, high eutrophication (stocked with carp and perch), and variable oxygen levels, potentially enhancing chela growth for agonistic interactions in dense populations. Future work could compare this data with larger data sets. SDI calculations quantify dimorphism strength, e.g., high in chela traits (up to

42.50%), emphasising conservation needs for this widespread but locally variable species in Bulgarian waters.

A recent study, conducted by Berber *et al.* (2025) at Atikhisar Reservoir in Çanakkale, Turkey, shows male cheliped growth for reproduction, reinforcing chela dimorphism's role in mating success across the *P. leptodactylus* range. Another study from Sapanca Lake in Turkey, shows sex ratio shifts but confirm male chela emphasis, while cheliped loss is higher in males due to aggression (10.7% vs. 9.8% females), confirming the results on the corpulence differences in the current study (Baltacı *et al.* 2023).

Chela traits link to fitness (Stein 1976), heightening vulnerability to overfishing and invasive displacement, since in Bulgaria, *P. leptodactylus* coexists with declining *A. astacus* (Trichkova *et al.* 2013), threatened by pollution and competition in protected basins (e.g., Natura 2000 sites) (Vladov 2024).

Acknowledgements. The author is forever grateful to Assoc. Prof. Angel Tsekov, PhD for the provided data for the current study, for the friendship and mentorship throughout all these years.

References

- Berber, S., Kale, S., Acarli, D. & Demirci, A. (2025) Reproduction of the narrow-clawed crayfish, *Pontastacus leptodactylus* (Eschscholtz, 1823) (Decapoda: Astacidea: Astacidae), in western Turkey. *Journal of Crustacean Biology*, 45(4): ruaf064, <https://doi.org/10.1093/jcbiol/ruaf064>
- Baltacı, M.A., Aydın, H., Seyhun, N. & Deniz, T. (2023) Morphometric Characteristics of Freshwater Crayfish (*Pontastacus leptodactylus* Eschscholtz, 1823) Caught in Sapanca Lake, Türkiye. *Journal of Limnology and Freshwater Fisheries Research* 9(2): 63-75. <https://doi.org/10.17216/LimnoFish.1149864>
- Hammer, Ø., Harper, D. & Ryan, P. (2001) PAST: Paleontological statistics software: Package for education and data analysis. *Palaeontologia Electronica*, 4(1): 9.
- Lovich, J.E. & Gibbons, J.W. (1992) A review of techniques for quantifying sexual size dimorphism. *Growth Development and Aging*, 56: 269-281.
- Roljić, R., Nikolić, V. & Savić, N. (2019) Morphological Variability and Sexual Dimorphism of Danube Crayfish *Pontastacus leptodactylus* Eschscholtz, 1823 from the Vrbas River. *Water Research and Management*, 9(2): 27-32.
- Stein, R.A. (1976) Sexual dimorphism in crayfish chelae: functional significance linked to reproductive activities. *Canadian Journal of Zoology*, 54(2): 220-227. <https://doi.org/10.1139/z76-024>
- Trichkova, T., Botev, I., Hubenov, Z., Kenderov, L., Todorov, M., Kozuharov, D., Deltshv, Ch. & Füreder, L. (2013) Freshwater Crayfish (Decapoda: Astacidae) Distribution and Conservation in Bulgaria. *Freshwater Crayfish*, 19(2): 243-248.
- Vasileva, P.L., Hubenova, T.A., Zaikov, A.N. & Stoyanov, I.Y. (2005) Morphometric Characteristics and Sexual Dimorphism of Matured Narrow-Clawed Crayfish (*Astacus leptodactylus* Esch., 1823 (Crustacea, Decapoda, Astacidae) from “Kardzhali” Artificial Lake. *Annual of Sofia University “St. Kliment Ohridski”, Faculty of Biology*, Book 1 – Zoology, 95: 45-57.
- Vasileva, P.L., Hubenova, T.A., Zaikov, A.N. & Stoyanov, I.Y. (2017) Morphometric Variability, Allometric Growth and Sexual Dimorphism in Narrow-Clawed Crayfish, *Astacus leptodactylus* Eschscholtz, 1823 (Crustacea: Decapoda) during the Ontogenesis. *Acta zoologica bulgarica*, Suppl. 8: 99-106.
- Vladov, K. (2024) Assessment of Freshwater Crayfish (Malacostraca: Astacidae) in Protected Aquatic Basins in Bulgaria. *Acta zoologica bulgarica*, 76(2): 253-262.