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Length–weight relations of 14 endemic and indigenous freshwater fish species (Actinopterygii) from the Aral Sea basin, Uzbekistan

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Abstract

Length–weight relations (LWR) were estimated for 14 endemic and indigenous fish species from the Aral Sea basin: *Alburnoides holciki* Coad et Bogutskaya, 2012; *Capoetobrama kuschakewitschi* (Kessler, 1872); *Cottus spinulosus* Kessler, 1872; *Glyptosternon oschanini* (Herzenstein, 1889); *Gobio lepidolaemus* Kessler, 1872; *Gobio nigrescens* (Keyserling, 1861); *Iskandaria kuschakewitschi* (Herzenstein, 1890); *Iskandaria pardalis* (Turdakov, 1941); *Paracobitis longicauda* (Kessler, 1872); *Sabanejewia aralensis* (Kessler, 1877); *Schizothorax fedtschenkoi* Kessler, 1872; *Triplophysa daryoae* Sheraliev, Kayumova et Peng, 2022; *Triplophysa ferganaensis* Sheraliev et Peng, 2021; and *Triplophysa uranoscopus* (Kessler, 1872). Measurements were taken for total length (0.1 cm precision) and total weight (0.1 g precision). The LWR parameters were determined using a linear logarithmic regression model of weight against length in which values for the slope of the regression, *b*, that are higher and lower than 3 indicate positive and negative allometric growth, respectively. The estimated values of parameter *b* ranged from 2.703 (*Iskandaria kuschakewitschi*) to 3.162 (*Gobio nigrescens*). The correlation coefficient (r^2) values varied from 0.951 to 0.993, indicating a strong positive relation between length and weight. The maximum total lengths of four of the species (*Glyptosternon oschanini*, *Iskandaria kuschakewitschi*, *Triplophysa daryoae*, and *Triplophysa uranoscopus*) constitute new records, and the LWRs of twelve fish species have hitherto not been available in FishBase.

Keywords

Amu Darya, endemic species, freshwater fish, length–weight relation, Syr Darya, Uzbekistan

Introduction

In Uzbekistan, all river basins are endorheic; therefore, fish diversity is poorer than in other regions. One-quarter of the fish species in the country are endemic (Mirabdullaev and Mullabaev 2020). The recent discovery of two species of *Triplophysa* Rendahl, 1933 from the upper reaches of the Syr Darya also confirms this statement (Sheraliev and Peng 2021; Sheraliev et al. 2022). The majority of endemic and indigenous fish species from the inland waters of Uzbekistan do not have commercial value but are important for aquatic ecosys-

tems (Mirabdullaev and Mullabaev 2020; Sheraliev and Peng 2021; Sideleva 2021).

A prerequisite in assessing the population characteristics of any fish species is to investigate its length–weight relation (LWR) (Le Cren 1951). LWRs provide basic knowledge for fisheries research, which is important for fish management and conservation (Çiçek et al. 2022). A few commercially important fish species in Uzbekistan have available LWR data (Kurbanov and Kamilov 2015; Kamilov et al. 2017; Sheraliev et al. 2019); however, no such studies on non-commercial endemic fish species have been undertaken. Because of this scarcity of information, the presently reported study was carried out to determine the LWR parameters of 12 endemic and two native fish species inhabiting the Aral Sea basin in Uzbekistan.

Materials and methods

A total of 676 individuals representing 14 endemic and native fish species were collected between March 2020 and June 2022 from the Syr Darya, Amu Darya, and Zeravshan rivers and their various tributaries using hand nets (Table 1). The following species were collected: Holcik's riffle minnow, *Alburnoides holciki* Coad et Bogutskaya, 2012; sharpray, *Capoetobrama kuschakewitschi* (Kessler, 1872); Turkestan sculpin, *Cottus spinulosus* Kessler, 1872; Oshanin's catfish, *Glyptosternon oschanini* (Herzenstein, 1889); Turkestan gudgeon, *Gobio lepidolaemus* Kessler, 1872; Hari gudgeon, *Gobio nigrescens* (Keyserling, 1861); Kuschakewitsch loach, *Iskandaria kuschakewitschi* (Herzenstein, 1890); Tajik loach, *Iskandaria pardalis* (Turdakov, 1941); eastern crested loach, *Paracobitis longicauda* (Kessler, 1872); Aral spined loach, *Sabanejewia aralensis* (Kessler, 1877); Zeravshan marinka, *Schizothorax fedtschenkoi* Kessler, 1872; Sokh stone loach, *Triplophysa daryoae* Sheraliev, Kayumova et Peng, 2022; Fergana stone loach, *Triplophysa ferganaensis* Sheraliev et Peng, 2021; and Zeravshan stone loach, *Triplophysa uranoscopus* (Kessler, 1872). The specimens collected were identified with the aid of Berg (1949), Turdakov (1963), Amanov (1985), Thoni et al. (2017), and Sheraliev and Peng (2021) as representing three orders, seven families, and ten genera (Fig. 1). The fishes were measured to the nearest 0.1 cm total length (TL) using a digital caliper and weighed to the nearest 0.01 g total weight (W). LWRs were calculated using the following equation

$$W = a\mathrm{TL}^b$$

and logarithmically transformed (Froese 2006) into

$$Log(W) = \log(a) + b \cdot \log(\mathrm{TL})$$

where W is the total body weight [g], TL is the total body length [cm], a is the intercept, and b is the slope. The 95% confidence limits of a and b, and the coefficient of determination (r^2) were calculated using the equations of Sparre and Venema (1998). All statistical analyses were performed using MS Excel 2019 software.

Table 1. Sampling locations of 14 endemic and indigenous freshwater fish species used in this study.

Order/Family/Species	Drainage (Basin)	Coordinates
Cypriniformes/Cobitidae		
Sabanejewia aralensis (Kessler, 1877)	Zeravshan River (Amu Darya basin)	39.677730°N, 67.078299°E
	Karatag River (Amu Darya basin)	38.345899°N, 68.057145°E
	Sherabad River (Amu Darya basin)	37.725809°N, 66.998718°E
Cypriniformes/Cyprinidae		
Schizothorax fedtschenkoi Kessler, 1872	Zeravshan River (Amu Darya basin)	39.677730°N, 67.078299°E
Cypriniformes/Gobionidae		
Gobio lepidolaemus Kessler, 1872	Kara Darya River (Syr Darya basin)	40.785837°N, 72.999462°E
Gobio nigrescens (Keyserling, 1861)	Zeravshan River (Amu Darya basin)	39.677730°N, 67.078299°E
Cypriniformes/Leuciscidae		
Alburnoides holciki Coad et Bogutskaya, 2012	Zeravshan River (Amu Darya basin)	39.677730°N, 67.078299°E
	Tupalang River (Amu Darya basin)	38.343337°N, 67.992137°E
	Surkhan Darya River (Amu Darya basin)	37.340607°N, 67.398966°E
Capoetobrama kuschakewitschi (Kessler, 1872)	Amu Darya River (Amu Darya basin)	37.235241°N, 67.677525°E
Cypriniformes/Nemacheilidae		
Iskandaria kuschakewitschi (Herzenstein, 1890)	Great Fergana Canal (Syr Darya basin)	40.479526°N, 70.888375°E
Iskandaria pardalis (Turdakov, 1941)	Tupalang River (Amu Darya basin)	38.343337°N, 67.992137°E
	Sherabad River (Amu Darya basin)	37.725809°N, 66.998718°E
Paracobitis longicauda (Kessler, 1872)	Zeravshan River (Amu Darya basin)	39.677730°N, 67.078299°E
	Tupalang River (Amu Darya basin)	38.343337°N, 67.992137°E
	Karatag River (Amu Darya basin)	38.385116°N, 68.081272°E
Triplophysa daryoae Sheraliev, Kayumova et Peng, 2022	Sokh River (Syr Darya basin)	40.049308°N, 71.100995°E
Triplophysa ferganaensis Sheraliev et Peng, 2021	Shohimardonsoy River (Syr Darya basin)	39.963237°N, 71.759454°E
Triplophysa uranoscopus (Kessler, 1872)	Zeravshan River (Amu Darya basin)	39.741008°N, 66.889978°E
Perciformes/Cottidae		
Cottus spinulosus Kessler, 1872	Sokh River (Syr Darya basin)	39.940108°N, 71.157773°E
Siluriformes/Sisoridae		
Glyptosternon oschanini (Herzenstein, 1889)	Margilansay River (Syr Darya basin)	40.355162°N, 71.803980°E

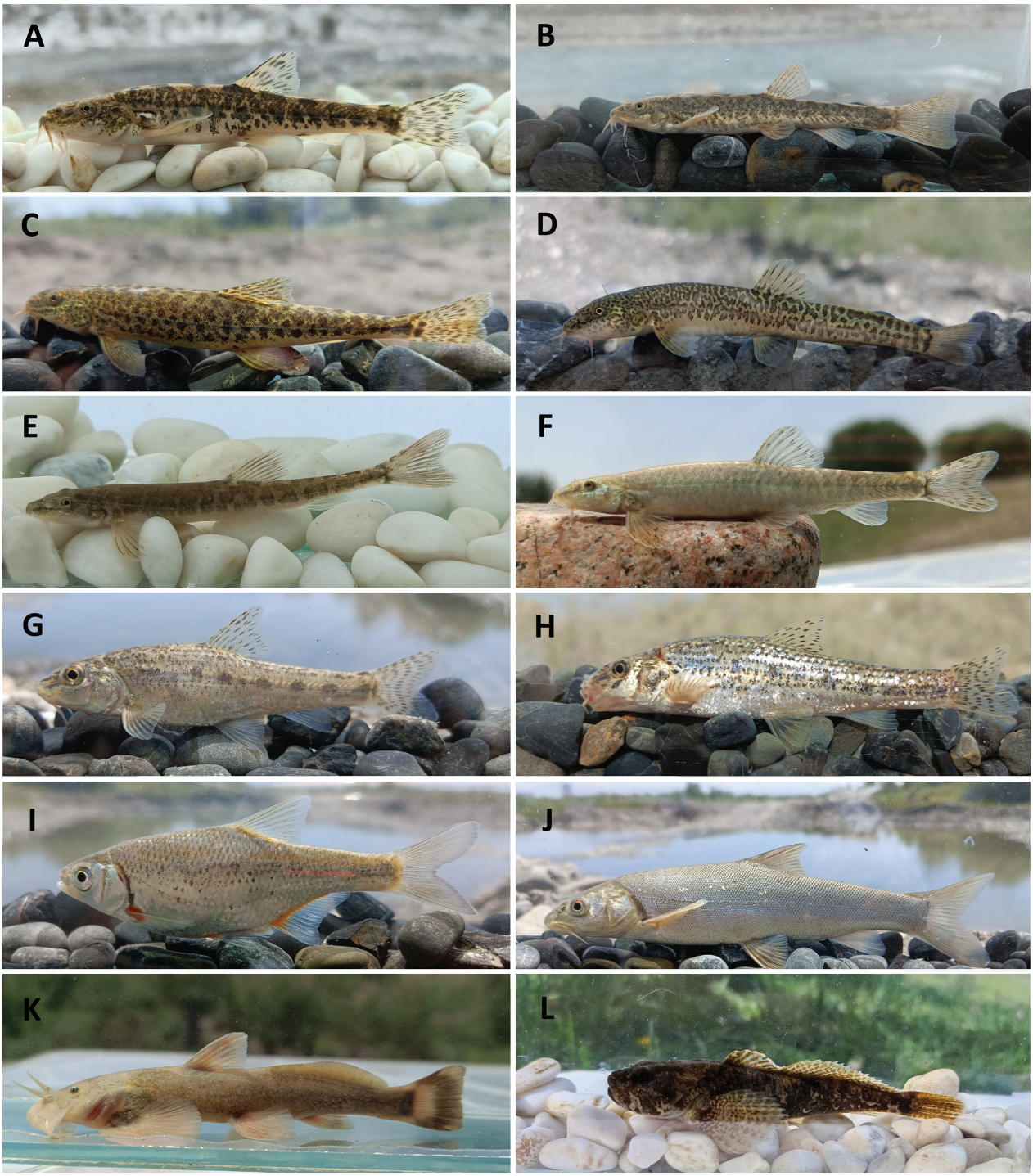

Figure 1. Twelve out of 14 fish species covered by the presently reported study: (**A**) *Triplophysa ferganaensis* (8.2 cm TL) from the Shakhimardan River; (**B**) *Triplophysa daryoae* (9.5 TL) from the Sokh River; (**C**) *Triplophysa uranoscopus* (9.8 cm TL) from the Zeravshan River; (**D**) *Paracobitis longicauda* (7.9 cm TL) from the Zeravshan River; (**E**) *Iskandaria kuschakewitschi* (5.2 cm TL) from the Great Fergana Canal; (**F**) *Iskandaria pardalis* (6.9 cm TL) from the Tupalang River; (**G**) *Gobio nigrescens* (6.1 cm TL) from the Zeravshan River; (**H**) *Gobio lepidolaemus* (7.4 cm TL) from the Kara Darya River; (**I**) *Alburnoides holciki* (7.1 cm TL) from the Zeravshan River; (**J**) *Schizothorax fedtschenkoi* (12.7 cm TL) from the Zeravshan River; (**K**) *Glyptosternon oschanini* (10.2 cm TL) from the Margilansay River; (**L**) *Cottus spinulosus* (6.3 cm TL) from the Sokh River.

Results

For all collected species, the coefficient of determination (r^2) ranged from 0.951 to 0.993, the *a* value ranged from 0.0046 to 0.0132, and the *b* values ranged from 2.703 to 3.234. Sample sizes, total length and total weight ranges, regression parameters, 95% confidence limits of *a* and *b* values, and coefficients of regression are given in Table 2. In LWRs, *b* values higher and lower than 3 indicate positive and negative allometric growth, respec-

Table 2. Descriptive statistics and estimated parameters of length–weight relations for 12 endemic and two native fish species caught from the Aral Sea basin, Uzbekistan.

Species	E	*N*	Total length [cm]		Weight [g]		Length–weight relation parameters					
			Min	Max	Min	Max	*a*	95%CL of *a*	*b*	95%CL of *b*	GT	r^2
*Alburnoides holci*ki		155	4.3	12.1	0.8	19.8	0.0087	0.0076–0.0099	3.156	3.085–3.226	+A	0.971
Capoetobrama kuschakewitschi[a]	+	17	4.7	13.7	0.7	16.3	0.0055	0.0037–0.0081	3.108	2.932–3.283	I	0.960
Cottus spinulosus[a]	+	39	3.9	10.2	0.7	12.6	0.0098	0.0064–0.0151	3.093	2.872–3.315	I	0.963
Glyptosternon oschanini[a]	+	12	9.1	**17.6**	9.4	69.3	0.0132	0.0093–0.0189	2.954	2.814–3.094	I	0.989
Gobio lepidolaemus[a]	+	16	4.4	10.9	0.9	18.8	0.0068	0.0042–0.0112	3.234	3.003–3.464	+A	0.951
Gobio nigrescens[a]		17	4.7	8.3	1.2	7.8	0.0090	0.0061–0.0134	3.162	2.955–3.369	+A	0.977
Iskandaria kuschakewitschi[a]	+	27	9.0	**14.6**	3.4	14.2	0.0102	0.0043–0.0244	2.703	2.502–2.887	–A	0.955
Iskandaria pardalis[a]	+	54	3.2	8.3	0.2	4.8	0.0069	0.0053–0.0089	2.946	2.790–3.102	I	0.982
Paracobitis longicauda	+	61	5.2	17.1	0.9	23.8	0.0121	0.0093–0.0157	2.710	2.599–2.820	–A	0.971
Sabanejewia aralensis[a]	+	134	3.3	7.1	0.2	2.2	0.0050	0.0044–0.0058	3.045	2.962–3.127	I	0.961
Schizothorax fedtschenkoi[a]	+	30	5.8	19.9	2.1	87.0	0.0116	0.0093–0.0146	2.949	2.848–3.050	I	0.989
Triplophysa daryoae[a]	+	59	4.6	**11.3**	0.8	9.1	0.0106	0.0084–0.0133	2.781	2.672–2.890	–A	0.964
Triplophysa ferganaensis[a]	+	37	2.6	10.3	0.1	6.7	0.0049	0.0041–0.0060	3.147	3.043–3.252	+A	0.982
Triplophysa uranoscopus[a]	+	18	3.4	**11.5**	0.3	11.6	0.0072	0.0037–0.0081	3.012	2.927–3.097	I	0.993

E = endemic fish species to the Aral Sea basin (plus signs); *N* = number of individuals; Min = minimum; Max = maximum; *a* = intercept; *b* = slope; CL = confidence limits; GT = growth type, I = isometric growth; –A = negative allometric growth; +A = positive allometric growth; r^2 = correlation coefficient.
[a]Data represent first reported LWR value; **bold** font indicates new maximum total length record for the species.

tively. According to their *b* values, *Iskandaria pardalis*, *Schizothorax fedtschenkoi*, *Glyptosternon oschanini*, *Triplophysa uranoscopus*, *Sabanejewia aralensis*, *Cottus spinulosus*, and *Capoetobrama kuschakewitschi* are isometric; *Iskandaria kuschakewitschi*, *Paracobitis longicauda*, and *Triplophysa daryoae* have negative allometry; and *Alburnoides holciki*, *Gobio lepidolaemus*, *Gobio nigrescens*, and *Triplophysa ferganaensis* have positive allometry (Table 2). The new maximum total lengths of *Glyptosternon oschanini*, *Iskandaria kuschakewitschi*, *Triplophysa daryoae*, and *Triplophysa uranoscopus* were updated.

Discussion

Overall, the expected range of *b* values for LWRs is 2.5–3.5 (Froese 2006) although the ideal value of *b* is 3.0 (Le Cren 1951). The results of the presently reported study are concordant with the expected range. It has been shown that when *b* is greater than three, fish grow faster in weight than in length (Islam et al. 2017; Yang et al. 2021). In addition, a *b* value lower than 3.0 signifies that fish expend more energy on axial growth than to accumulate mass, which could help them seek food and avoid predators (Yang et al. 2021). The calculations performed in this study indicate that, in *Iskandaria kuschakewitschi*, *Paracobitis longicauda*, and *Triplophysa daryoae*, parameter *b* was lower than 3.0, which may be due to cold water, severe environment, low availability of food resources, the large abundance of predators and food competitors, and other unpredictable reasons (Le Cren 1951; Rypel and Richter 2008; Wang et al. 2016). On the other hand, several scientific results indicate that the *b* value of the same species can vary depending on several factors, including environmental factors such as habitat type, seasonality, and geographic location; biotic factors such as sex, gonadal maturity, health, degree of stomach fullness, food competition, and trophic potential of rivers or ponds; and anthropogenic factors such as gear selectivity, number of examined specimens, and a length range of observed individuals (Hossain et al. 2006; Siddik et al. 2016; Islam et al. 2017; Sheraliev et al. 2019). In previous studies, the maximum lengths of *Glyptosternon oschanini*, *Iskandaria kuschakewitschi*, *Triplophysa daryoae*, and *Triplophysa uranoscopus* were given as 10.4, 11.0, 11.2, and 9.0 cm, respectively (Thoni et al. 2017; Froese and Pauly 2022; Sheraliev et al. 2022). By examining a different subsample in the presently reported study, these records were revised to 17.6, 14.6, 11.3, and 11.5 cm, respectively.

In conclusion, our study provides partial information on the 14 endemic and native fish species from the Aral Sea basin as a contribution to the online FishBase, which could help to understand better the fishes of the region and contribute to the management and conservation of fishes in central Asia.

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