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Length–weight relationship and condition factor of thirteen fish species in the Tigris river before the construction of Ilisu and Cizre dams, Türkiye

Relación longitud–peso y factor de condición de trece especies de peces en el río Tigris antes de la construcción de las presas de Ilisu y Cizre, Turquía

Serbest Bilici

Şırnak University, Faculty of Agriculture, Department of Animal Science. Şırnak, Türkiye.
**Corresponding Author: serbestbilici@hotmail.com.tr, serbestbilici@gmail.com*

ABSTRACT

The Ilısu Hydroelectric Power Plant (HEPP), situated on the Tigris river in Türkiye, began filling and forming a reservoir in 2021. In addition, there are plans for the construction of the upcoming Cizre HEPP. This situation has the potential to significantly impact the bio-ecology of fish species in the area. The research aimed to determine the length-weight relationships (LWR) and condition factors of thirteen fish species in the Tigris River: *Arabibarbus grypus, Acanthobrama marmid, Alburnus sellal, Carassius gibelio, Cyprinion kais, Cyprinion macrostomus, Chondrostoma regium, Paracapoeta trutta, Capoeta umbla, Garra rufa, Squalius lepidus, Luciobarbus esocinus* and *Luciobarbus mystaceus*, where Ilisu and Cizre dams reservoir will be formed. Length-weight relationships (LWRs) were determined using the formula $W = aL^b$, where W represents weight and L represents length. Three types of lengths were considered: total length, fork length, and standard length. The exponent values (b) varied across the species, ranging from 2.7875 for *Acanthobrama marmid* to 3.2214 for *Carassius gibelio*. The relationships between length and weight were found to be highly significant, as indicated by the R^2 values, which were all greater than 0.80, except for *Alburnus sellal* and *Garra rufa*, which had lower values below 0.80. The condition factors were calculated using Fulton's condition factor (K) and relative condition factor (Kn). In all species, except for *Arabibarbus grypus* and *Chondrostoma regium*, the condition factors were greater than 1 (K>1). However, for *Capoeta umbla* and *Garra rufa*, the relative condition factor (Kn) was less than 1 (Kn<1).

Key words: allometry; freshwater fish; growth curve; isometry; reservoirs

RESUMEN

La Central Hidroeléctrica de Illsu situada en el río Tigris en Turquía, comenzó a llenarse y formar un embalse en 2021. Además, hay planes para la construcción una próxima central hidroeléctrica en Cizre. Esta situación tiene el potencial de impactar significativamente la bioecología de las especies de peces en el área. La investigación tuvo como objetivo determinar las relaciones longitud-peso (LWR) y los factores de condición en trece especies de peces en el río Tigris: *Arabibarbus grypus*, *Acanthobrama marmid*, *Alburnus sellal*, *Carassius gibelio*, *Cyprinion kais*, *Cyprinion macrostomus*, *Chondrostoma regium*, *Paracapoeta trutta*, *Capoeta umbla*, *Garra rufa*, *Squalius lepidus*, *Luciobarbus esocinus* y *Luciobarbus mystaceus*, donde se formarán los embalses de las represas Ilısu y Cizre. Las relaciones longitud-peso (LWR, por sus siglas en inglés) se determinaron utilizando la fórmula $W = aL^b$, donde W representa el peso y L representa la longitud. Se consideraron tres tipos de longitudes: longitud total, longitud a la horquilla y longitud estándar. Los valores del exponente (b) variaron entre las especies, desde 2,7875 para *Acanthobrama marmid* hasta 3,2214 para *Carassius gibelio*. Las relaciones entre la longitud y el peso fueron altamente significativas, como lo indican los valores de R^2, que fueron todos mayores de 0,80, excepto para *Alburnus sellal* y *Garra rufa*, que tuvieron valores inferiores a 0,80. Los factores de condición se calcularon usando el factor de condición de Fulton (K) y el factor de condición relativa (Kn). En todas las especies, excepto en *Arabibarbus grypus* y *Chondrostoma regium*, los factores de condición fueron mayores de 1 (K>1). Sin embargo, para *Capoeta umbla* y *Garra rufa*, el factor de condición relativa (Kn) fue inferior a 1 (Kn<1).

Palabras clave: alometría; peces de agua dulce; isometría; curva de crecimiento; embalses

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INTRODUCTION

Length–weight regressions and condition factors are valuable tools in fisheries science. They estimate the weight or length of individual fish, compare conditions between fish populations, and monitor overall fish population health [1].

These tools are instrumental in assessing stocks and estimating biomass and are particularly useful in understanding food availability and population growth. Seasonal and annual variations in the average condition of each population offer valuable insights into the population's overall health [2, 3].

The Tigris river is of great significance as one of the major rivers in the Middle East. It originates in the southeastern mountains of Turkey, flows south through Iraq, and eventually empties into the Persian Gulf via the Shatt Al-Arab waterway [4]. The Tigris River Basin is undergoing significant development, with plans for the construction of eight dams and eight hydroelectric power plants. These projects aim to fulfill various purposes such as water supply, irrigation, and hydropower [5]. Notably, the Ilisu dam, one of the largest on the Tigris River, is nearing completion.

Although dams bring certain benefits, it is crucial to acknowledge the negative environmental impacts associated with reservoir creation [6]. Dams have been known to have significant effects on fish populations, including the transformation of flowing habitats into stagnant ones, obstruction of fish migration, and alterations in downstream flows, water quality, and habitat [7]. As a result, these factors can greatly affect the growth and reproduction of fish species [6, 7].

Considering the potential consequences of dam construction, it is essential to examine the biological characteristics of fish in lotic systems before implementing such projects. This research will provide valuable insights into the level of impact on fish species, aiding in future planning and monitoring efforts.

According to research conducted by [4], the Turkish region of the Tigris river basin is home to a diverse range of fish species, at least 46 in total including both natural and exotic/invasive species. In the current investigation, thirteen native fish species from the Tigris river were specifically studied. Some of these fish species play a vital role in the lives of rural communities, as they provide nutrition and serve as a source of livelihood and income for many local fishermen [5].

Numerous studies have examined the biological characteristics of fish species in the upper region of the Tigris River in Turkey, as documented by [8, 9, 10, 11, 12, 13]. However, there is a lack of research specifically focused on the Ilisu and Cizre dam reservoir area. The objective is to determine the length–weight relationships for selected species and gain insights into their condition factors. Therefore, determining the basic information on the biological characteristics of fish species before the formation of the reservoir is essential, as it will provide a solid foundation for future studies.

MATERIAL AND METHODS

The length–weight relationships and condition factor of 13 species belonging to *Cyprinidae* and *Leuciscidae* families were examined. These species include *Arabibarbus grypus* (Heckel, 1843), *Acanthobrama marmid* Heckel, 1843, *Alburnus sellal* Heckel, 1843, *Carassius gibelio* (Bloch, 1782), *Cyprinion kais* Heckel, 1843, *Cyprinion macrostomus* Heckel, 1843, *Chondrostoma regium* (Heckel, 1843), *Paracapoeta trutta* (Heckel, 1843), *Capoeta umbla* (Heckel, 1843), *Garra rufa* (Heckel, 1843), *Squalius lepidus* Heckel, 1843, *Luciobarbus esocinus* Heckel, 1843 and *Luciobarbus mystaceus* (Pallas, 1814).

Fish samples were collected monthly from the Tigris river, specifically from the region between the Ilisu Dam (37°31′ 27′ ′ N | 41°50′ 48′ ′ E, altitude 409 masl) and Cizre town a (37°19′ 12′ ′ N | 42°12′ 56′ ′ E, altitude 367 masl)(FIG.1). The sampling period extended from January 2021 to December 2021.

FIGURE 1. Map of the study area which samples collected

During the study period, a total of 1784 fish specimens were captured using various types of gill nets with mesh sizes ranging from 18 to 60 mm. Afterwards, the fish were identified and their total, fork, and standard lengths were measured up to 1 mm using an ichthyometer.Body weight was determined using a digital balance (Mettler Toledo ML6001T, Switzerland), with an accuracy of 0.1 g.

To establish the length–weight relationship, the growth formula proposed by [1, 14] was used. The formula is represented as $W = aL^b$, where W represents the body weight of the fish, L denotes the total, fork, or standard lengths, a represents the intercept of the regression curve, and b represents the regression coefficient. To simplify the analysis, the equation was transformed into a logarithmic form as suggested by [14], resulting in $Log\ W = Log\ a + b \times Log\ L$.

Published length–weight relationships can sometimes be challenging to apply due to variations in length measurement types. Therefore, separate length–weight relationships were calculated based on the total (TL), fork (FL), and standard (SL) lengths. The regression coefficient (b value) for each species was tested using a *t–test* at the 0.05 significance level to determine if it significantly differed from 3 [15].

The condition factor, also known as the Fulton factor (K), was estimated for each species using the equation $K = (W \cdot L^{-3}) \times 100$, where W represents the body weight in grams and L represents the fork length in millimeters [16, 17]. Additionally, the relative condition factor (Kn) was calculated using the equation $Kn = W/W'$, where W is the actual body weight in grams and W' is the calculated weight derived from the length–weight relationship.

RESULTS AND DISCUSSION

The length–weight relationships and condition factor of the examined species were analyzed separately for male, female, and combined sexes. The results, including the estimated parameters *a*, *b*, R^2, and confidence intervals for *a* and *b* are presented in TABLE I. This study provides the first information on the length–weight relationships for the species *S. lepidus*.

The sample sizes varied, with the smallest being 8 specimens for *L. esocinus* and the largest being 404 specimens for *P. trutta*.

TABLE I
Descriptive statistics and length–weight relationship parameters for 13 selected fish species of the Tigris River, southeast Türkiye, from January 2021 to December 2021

Family/Species	N	Length	Mean length ± SD (Min–Max) (mm)	Mean weight ± SD (Min–Max) (g)	Log *a*	*a*	*b*	R^{2}*	SE of *b* (95% CI of *b*)	Growth type
Leuciscidae *Acanthobrama marmid*	145	TL	144.7 ± 14.17 (109–178)	28.3 ± 8.231 (10.9–55.5)	-4.5826	0.0000261	2.7875	0.8236	0.1097 (2.57–3.00)	-A
		FL	129.4 ± 13.10 (97–160)		-4.2755	0.0000530	2.7062	0.8096	0.1097 (2.49–2.92)	
		SL	118.7 ± 12.04 (88–148)		-4.2034	0.0000626	2.7203	0.8301	0.1029 (2.52–2.92)	
Alburnus sellal	106	TL	180.1 ± 13.6 (145–212)	46.1 ± 12.6 (20–83)	-5.4303	0.0000037	3.1394	0.7489	0.1783 (2.78–3.49)	+A
		FL	163.5 ± 12.5 (133–195)		-5.3673	0.0000043	3.1708	0.7801	0.1651 (2.84–3.50)	
		SL	153.0 ± 12.1 (124–180)		-5.0678	0.0000086	3.0752	0.77834	0.1586 (2.76–3.39)	
Chondrostoma regium	279	TL	211.4 ± 24.0 (155–328)	66.2 ± 27.7 (20–225)	-5.4308	0.0000037	3.1096	0.8982	0.063 (2.99–3.23)	I
		FL	193.3 ± 22.5 (143–305)		-5.1126	0.0000077	3.0233	0.8912	0.063 (2.90–3.15)	
		SL	178.7 ± 21.1 (130–280)		-4.9500	0.0000112	2.9970	0.9019	0.059 (2.88–3.11)	
Squalius lepidus	14	TL	227.0 ± 63.0 (146–303)	165.6 ± 111.3 (38–348)	-4.5249	0.0000299	2.8295	0.9799	0.117 (2.57–3.09)	-A
		FL	208.5 ± 61.6 (126–282)		-3.9283	0.0001180	2.6187	0.9760	0.119 (2.36–2.88)	
		SL	181.0 ± 53.0 (112–244)		-3.8263	0.0001492	2.6445	0.9731	0.127 (2.37–2.92)	
Cyprinidae *Arabibarbus grypus*	27	TL	539 ± 240.4 (215–1077)	1446 ± 1760 (63.3–7960)	-4.8696	0.0000135	2.8673	0.9917	0.052285 (2.76–2.98)	-A
		FL	498.5 ± 226.1 (195–997)		-4.5680	0.0000270	2.7926	0.9904	0.05494 (2.68–2.91)	
		SL	460.3 ± 205.9 (180–920)		-4.6316	0.0000234	2.8519	0.9912	0.05372 (2.74–2.96)	
Paracapoeta trutta	404	TL	212.7 ± 40.2 (113–355)	94.4 ± 60.3 (14–395)	-5.4195	0.0000038	3.1529	0.9501	0.036 (3.08–3.22)	+A
		FL	189.6 ± 36.1 (100–317)		-5.2075	0.0000062	3.1288	0.9478	0.037 (3.08–3.20)	
		SL	176.5 ± 34.3 (93–298)		-4.9642	0.0000109	3.0643	0.9490	0.035 (2.99–3.13)	
Capoeta umbla	105	TL	320.6 ± 60.9 (165–483)	283.4 ± 164.4 (38–857)	-4.9795	0.0000105	2.9460	0.9496	0.067 (2.81–3.08)	-A
		FL	291.2 ± 56.1 (150–438)		-4.7690	0.0000170	2.9108	0.9417	0.071 (2.77–3.05)	
		SL	267.8 ± 52.7 (140–405)		-4.4856	0.0000327	2.8377	0.9281	0.078 (2.68–2.99)	
Carassius gibelio	169	TL	167.0 ± 33.5 (100–235)	77 ± 46 (11–200)	-5.3313	0.0000047	3.2214	0.9662	0.0466 (3.29–3.31)	+A
		FL	152.5 ± 30.0 (90–220)		-5.3962	0.0000040	3.3090	0.9697	0.0453 (3.22–3.21)	
		SL	134.2 ± 27.5 (80–190)		-4.8944	0.0000128	3.1601	0.9691	0.0437 (3.07–3.25)	
Cyprinion kais	141	TL	144.9 ± 17.3 (79–187)	31.3 ± 12.6 (11–76)	-5.1116	0.0000077	3.0467	0.8657	0.1065 (2.83–3.26)	I
		FL	126.1 ± 15.1 (67–163)		-4.8776	0.0000133	3.0229	0.8432	0.1157 (2.79–3.25)	
		SL	116.3 ± 12.6 (60–148)		-4.6001	0.0000251	2.9400	0.8580	0.1061 (2.72–3.15)	
Cyprinion macrostomus	302	TL	169.9 ± 27.6 (95–267)	54.2 ± 31.3 (6–222)	-5.2977	0.0000050	3.1340	0.9578	0.038 (3.06–3.21)	+A
		FL	147.3 ± 24.1 (85–230)		-5.1175	0.0000076	3.1413	0.9527	0.040 (3.06–3.22)	
		SL	136.1 ± 22.6 (75–215)		-4.9190	0.0000121	3.0990	0.9614	0.036 (3.03–3.17)	
Garra rufa	29	TL	168.0 ± 13.2 (142–193)	52.1 ± 13.3 (29–75)	-4.6357	0.0000231	2.8503	0.7653	0.303 (2.22–3.42)	-A
		FL	153.1 ± 12.1 (128–175)		-4.3961	0.0000402	2.7934	0.7553	0.305 (2.17–3.42)	
		SL	140.1 ± 11.4 (116–163)		-4.1872	0.0000650	2.7460	0.7632	0.294 (2.14–3.35)	
Luciobarbus esocinus	5	TL	377.3 ± 124.7 (273–580)	627.3 ± 650 (196–2000)	-4.633	0.0000233	2.8410	0.9830	0.152 (2.47–3.21)	-A
		FL	262.8 ± 16.6 (245–279)		-4.035	0.0000923	2.6500	0.9870	0.125 (2.35–2.96)	
		SL	241.6 ± 13.0 (226–256)		-3.846	0.0001426	2.6110	0.9740	0.172 (2.19–3.03)	
Luciobarbus mystaceus	58	TL	433.7 ± 64.3 (295–570)	198.3 ± 94.5 (45–440)	-5.1178	0.0000076	3.0165	0.9800	0.058 (2.90–3.13)	I
		FL	388.0 ± 57.4 (263–513)		-4.9368	0.0000116	3.0071	0.9708	0.069 (2.87–3.15)	
		SL	361.9 ± 54.7 (244–473)		-4.6752	0.0000211	2.9355	0.9765	0.061 (2.81–3.06)	

Sample size (N); standard deviation (SD), coefficient of determination (R^2); standard error of ***b*** (SE); confidence interval (CI); length–weight parameters (***a***–intercept and ***b***–slope); type of growth (I– isometry, +A positive allometry, -A negative allometry); Min. and Max. minimum and maximum values of lengths in mm and weights in g

The samples in the study exhibited a wide range of average total lengths, varying from 79 to 1077 mm. Fork lengths ranged from 75 to 1000 mm, while standard lengths ranged from 70 to 950 mm. Additionally, the total weight of the samples ranged from 10.9 to 7,960 g. The exponent *b* values for the length–weight relationships ranged from 2.7875 (*A. marmid*) to 3.2214 (*C. gibelio*) for total length, from 2.6187 (*A. marmid*) to 3.309 (*C. gibelio*) for fork length, and from 2.7875 (*A. marmid*) to 3.15 (*C. gibelio*) for standard length. The distribution of *b* exponents of the length–weight relationship for the 13 species examined in this study is given in FIG. 2. The coefficients of determination (R^2) for the regressions ranged from 0.7489 to 0.9970, and all were statistically significant ($P<0.01$).

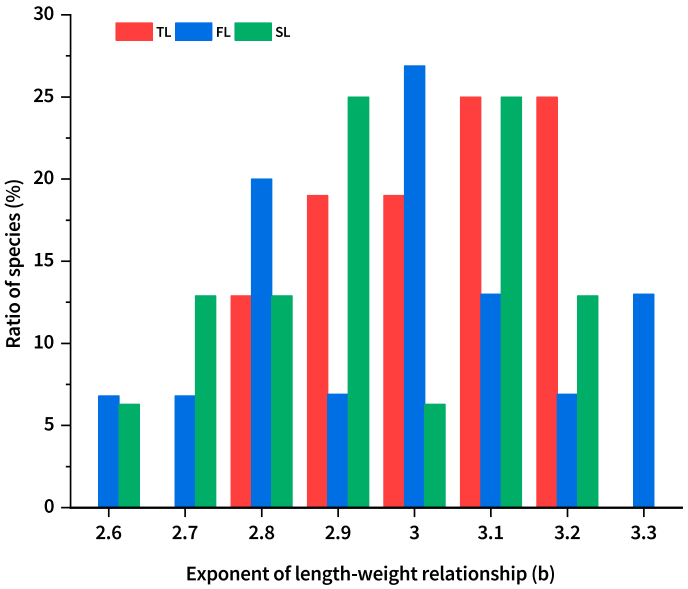

FIGURE 2. Distribution of b values of the length–weight relationships of 13 selected fish species of the Tigris River, southeast Türkiye

The *b* value was calculated for fish to determine if their growth follows an isometric or allometric pattern. If the *b* value is not significantly different from 3.0, it indicates isometric growth. However, if the *b* value is less than 3.0, it suggests that weight increases at a slower rate compared to length (negative allometric growth), while a value greater than 3.0 suggests that weight increases at a faster rate (positive allometric growth) [18]. According to TABLE I, out of the 13 species observed, 3 exhibited isometric growth, 6 showed negative allometric growth, and 4 displayed positive allometric growth.

The study revealed several noteworthy findings regarding the *b* values of various fish species in different locations. *A. marmid* exhibited a *b* value of 2.7875, higher than the 2.678 reported in the Karakaya Dam Lake by Uçkun and Gökçe [17]. Conversely, samples from Atatürk Dam Lake and the Tigris River near Diyarbakır showed a *b* value exceeding 3 [19]. Similarly, *A. sellal* and *C. regium* in this study had "b" values above 3, consistent with previous research [20, 21, 22, 23, 24]. For *C. gibelio*, the calculated *b* value was 3.2214, close to the range of 2.856 to 3.149 observed in other populations [25, 26, 27, 28].

G. rufa had a *b* value of 2.8503, differing from the 2.989 reported in the Merzimen stream by Uçkun and Gökçe [17], with similar results found in Iranian rivers [29, 30]. *A. grypus* showed a *b* value of 2.8673, consistent with values observed in Turkish and Iranian rivers, indicating its preference in the Tigris River, as supported by other studies [31, 32, 33, 34]. *C. macrostomus* displayed a *b* value of 3.1340, contrasting with lower values from the Karakaya Dam Lake [35] and higher values from the Gamasiab River [36]. *C. kais* showed a *b* value of 3.0467, similar to results from the Karakaya Dam Lake (Turkey) [35], while a higher value of 3.44 was recorded in the Gamasiab River (Iran) [36]. *P. trutta* showed a *b* value of 3.1529 with variations from 2.79 to 3.335 in other populations [8, 20, 37]. *Capoeta umbla* exhibited a *b* value of 2.9460 in this study, consistent with findings from other studies [38, 39]. *L. mystaceus* had a *b* value of 3.0165, compatible with the population in the Atatürk Dam Lake [40]. Lastly, *L. esocinus* showed a *b* value of 2.841 in this study, with variations from 2.871 to 3.2187 in other populations [32, 41, 42, 43, 44].

Studies on fishes showed that the *b* value does not only vary between species, but also shows differences in sex and dietary habits of the same species. Many more factors may affect the length–weight relationship in fish, genetic and environmental, including growth phase, season, gonad maturity, size range, health and general fish condition and preservation techniques [16, 45]. These factors have not been considered in this study.

Mean condition factor of fish studied in the present study ranged between 0.7751 (*A. grypus*) and 1.5517 (*C. macrostomus*) (TABLE II). The values of Fulton's condition factor for most fish species were being >1 indicate that growth of these species were perfect condition whereas *A. grypus* and *C. regium* were being <1. Although Froese [46] has reported that small specimens have a higher condition factor than large specimens. All these species the smallest and the largest individuals appeared to have a higher condition factor, suggesting that the data are not independent but may be influenced by physiological conditions of fish [18, 47, 48].

In fish, the factor of condition (K) reflects, through its variations, information on the physiological state of the fish in relation to its welfare, age and reproductive stages the species as well as environmental conditions such as temperature, salinity and seasonality [11, 25, 47].

Average relative condition factor (K_n) were calculated as >1 in all species except for *C. umbla* and *G. rufa* as Kn<1. Mean K_n was lowest in *G. rufa* (0.7787–1.2051) and highest in *P. trutta* (1.0090 ± 0.1299).

Monthly fluctuations in condition factor (K) of thirteen fish from the Tigris River are presented in FIGS. 3 and 4.

The condition factor ranged from 0.85 to 1.96 in winter, 0.85 to 1.84 in spring, 0.69 to 1.78 in summer, and 0.85 to 1.97 in autumn. In the majority of the studied species, the condition factor was found to be higher during the summer and autumn seasons, which aligns with expectations. However, certain species such as *A. grypus*, *L. esocinus*, *C. gibelio*, *C. regium*, and *S. lepidus* exhibit a high condition factor during the winter months due to their feeding habits. The lower values observed during the summer months may be attributed to their reproductive activity [49, 50]. Factors such as the state of fullness of the alimentary canal and the presence of parasites can also influence the condition factor [45, 47].

Some of the research findings align with the existing literature on the condition factor of the fish species under study, while others do not. These variations are believed to be influenced by the health

TABLE II
Sample sizes (N), condition factors (K), and relative condition factors (Kn) of fish collected from the Tigris River from January 2021 to December 2021

Species	N	K		K_n	
		Range	Mean ± SD	Range	Mean ± SD
Acanthobrama marmid	145	0.5799–1.6067	1.2836 ± 0.1590	0.4747–1.2661	1.0081 ± 0.1238
Alburnus sellal	106	0.4882–1.2589	1.0326 ± 0.1216	0.4781–1.2129	1.0077 ± 0.1176
Chondrostoma regium	279	0.5977–1.2033	0.8783 ± 0.1024	0.6843–1.3786	1.0068 ± 0.1173
Squalius lepidus	14	1.0798–1.9786	1.5904 ± 0.2729	0.7031–1.2132	1.0078 ± 0.1243
Arabibarbus grypus	27	0.5270–1.0669	0.7751 ± 0.1370	0.7491–1.2654	1.0094 ± 0.1436
Carassius gibelio	169	1.2355–2.9277	1.9036 ± 0.2519	0.6945–1.5595	1.0069 ± 0.1210
Cyprinion kais	141	0.7813–1.9192	1.4611 ± 0.2363	0.5593–1.3320	1.0126 ± 0.1525
Cyprinion macrostomus	302	0.9216–2.5000	1.5517 ± 0.1716	0.6106–1.7094	1.0061 ± 0.1106
Paracapoeta trutta	404	0.3729–2.2625	1.2274 ± 0.1605	0.3105–1.8434	1.0090 ± 0.1299
Capoeta umbla	105	0.7165–1.5009	1.0395 ± 0.1577	0.5582–1.2556	0.8098 ± 0.1292
Garra rufa	29	1.0254–1.7123	1.3786 ± 0.1807	1.0068 ± 0.1173	0.7787–1.2051
Luciobarbus esocinus	5	1.2340–1.4329	1.3314 ± 0.0715	0.9371–1.0857	1.0014 ± 0.0535
Luciobarbus mystaceus	58	0.9301–1.60741	1.2087 ± 0.1335	0.7750–1.3369	1.0059 ± 0.1111

SD: standard deviation

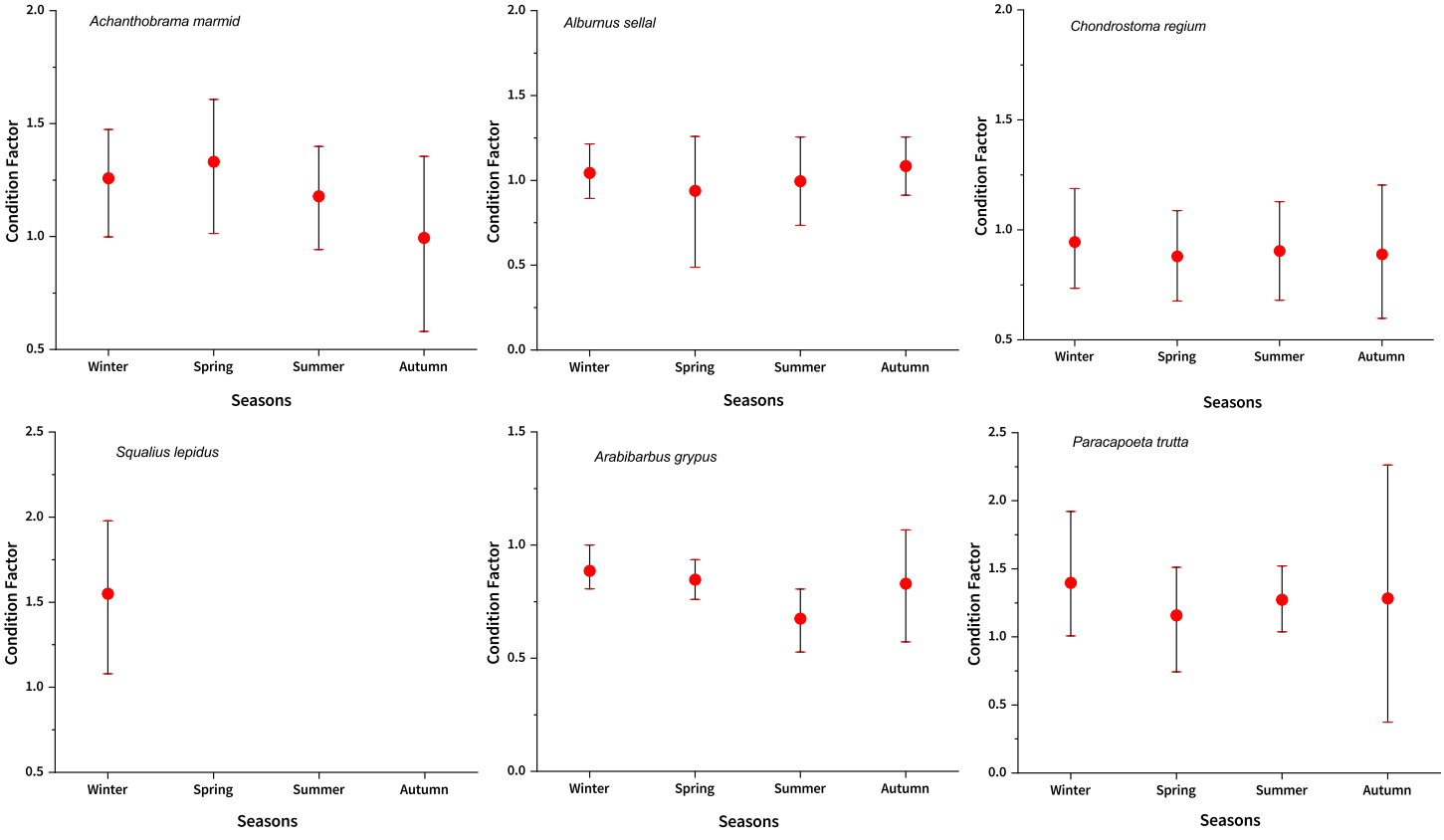

FIGURE 3. Seasonal variation in condition factor (K) of fish collected from the Tigris river during January, 2021 to December, 2021

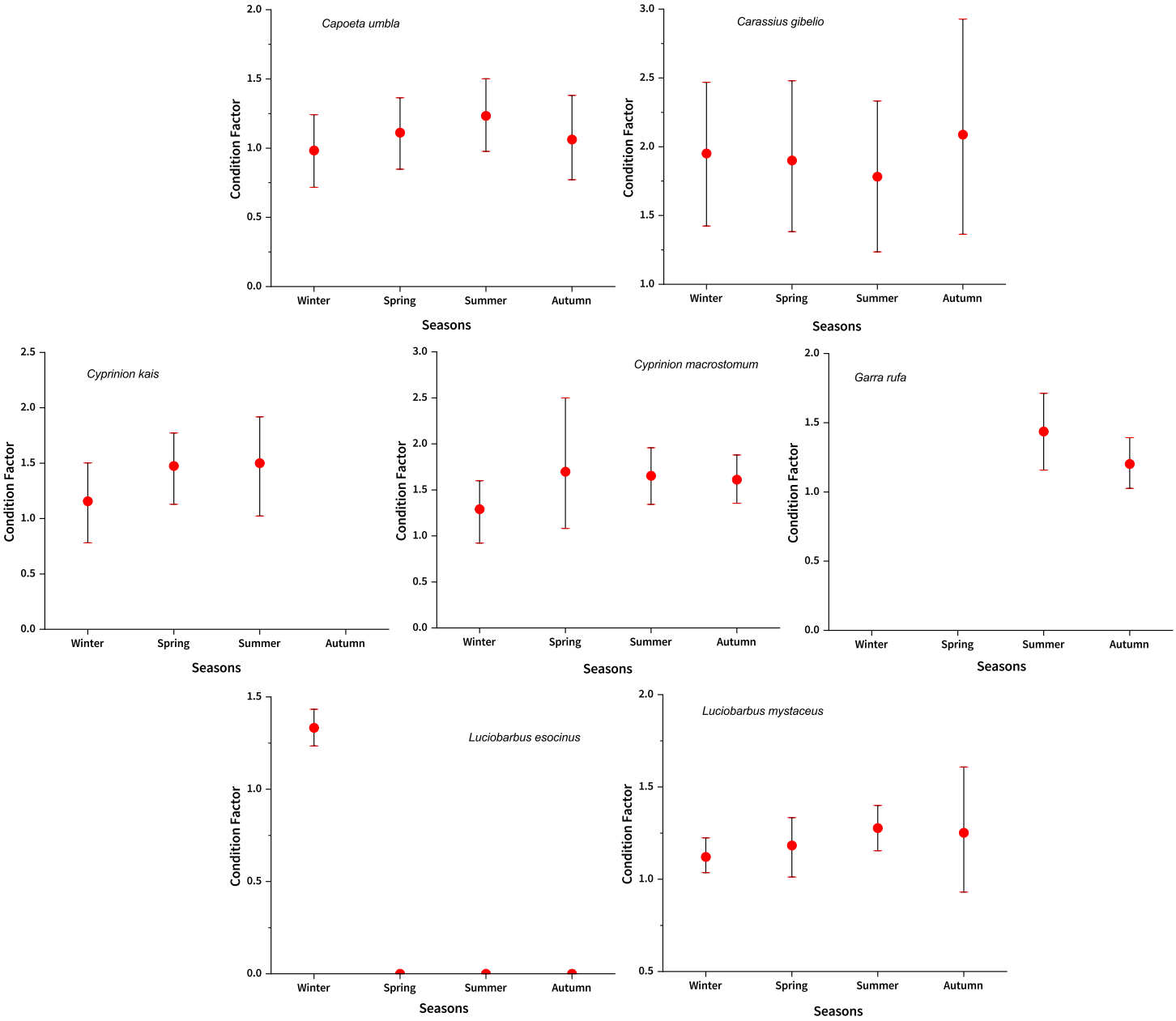

FIGURE 4. Seasonal variation in condition factor (K) of fish collected from the Tigris river during January, 2021 to December, 2021

status of the fish, its morphology, and the local ecological conditions of its habitat. The condition factor serves as an indicator of fish health and provides insights into specific aspects of fish species' physiology [26, 27, 37, 51]. Furthermore, a higher condition factor value is directly associated with better health status in different fish species.

CONCLUSIONS

This study has yielded novel insights into the length-weight relationship and status of freshwater fish species within the Tigris River, Türkiye. Given the eventual return of this river system to a reservoir, it becomes imperative to assess the length-weight relationship and status of these fish species. Such assessments will offer a basis for comparison in future endeavors aimed at managing and conserving these species, as well as others within the basin. Moreover, enhancing our understanding of fish population dynamics and ecological interactions will play a pivotal role in advancing fisheries development efforts.

Conflict of Interest

The author state that do not have any conflicts of interest.

BIBLIOGRAPHIC REFERENCES

[1] Schneider JC, Laarman PW, Gowing H. Length–weight relationships. In: Schneider JC, editor. Manual of fisheries survey methods II: with periodic updates [Internet]. Ann Arbor (Michigan, USA): Michigan Dept. of Natural Resources, Fisheries Division; 2000 [cited 25 Jan. 2024]. Chapter 17. Available in: https://goo.su/OECL

[2] Petrakis G, Stergiou KI. Weight–length relationships for 33 fish species in Greek waters. Fish. Res. [Internet]. 1995; 21(3–4):465–469. doi: https://doi.org/cbm7qk

[3] Valset A, Bouchon–Navaro Y, Louis M, Bouchon C. Weight–length relationships for 20 fish species collected in the mangroves of Guadeloupe (Lesser Antilles). J. Appl. Ichthyol. [Internet]. 2007; 24(1):99–100. doi: https://doi.org/b9jzgh

[4] Kaya C, Turan D, Ünlü E. The latest status and distribution of fishes in upper Tigris River and two new records for Turkish freshwaters. Turkish J. Fish. Aquat. Sci. [Internet]. 2016; 16:545–562. doi: https://doi.org/mqrh

[5] Ünlü E. Appendix 5: Fisheries and aquaculture in the Euphrates and Tigris Basin in Turkey. In: FAO. Report of the Expert Meeting on the Review of Fisheries and Aquaculture Activities in the Tigris Euphrates Basin. Rome: FAO Fisheries and Aquaculture. 2014; p. 19–58.

[6] Brismar A. River systems as providers of goods and services: a basis for comparing desired and undesired effects of large dam projects. Environ. Manag. 2002; 29(5):598–609. doi: https://doi.org/dktd8h

[7] Nunes DMF, Magalhães ALB, Weber AA, Gomes RZ, Normando FT, Santiago KB, Rizzo E, Bazzoli N. Influence of a large dam and importance of an undammed tributary on the reproductive ecology of the threatened fish matrinxã *Brycon orthotaenia* Günther, 1864 (Characiformes: Bryconidae) in southeastern Brazil. Neotrop. Ichthyol. 2015; 13(2):317–324. doi: https://doi.org/f7kks6

[8] Ünlü E. Dicle Nehri'nde yaşayan *Capoeta trutta* (Heckel, 1843)'nın biyolojik özellikleri üzerinde çalışmalar [Studies on the biological characters of *Capoeta trutta* (Heckel,1843) in Tigris River]. Doğa Turk. Zool. Derg. 1991; 15(1):22–38. Turkish.

[9] Ünlü E, Balci K. Observation on the reproduction of *Leuciscus cephalus orientalis* (Cyprinidae) in Savur Stream (Turkey). Cybium [Internet]. 1993; 17(3):241–250. doi: https://doi.org/g639fp

[10] Ünlü E, Balci K , Meriç N. Aspects of the biology of *Liza abu* (Mugilidae) in the Tigris River (Turkey). Cybium [Internet]. 2000; 24(1):27–43. doi. https://doi.org/g639fq

[11] Bilici S, Çiçek T, Ünlü E. Observation on the age, growth and somatic condition of *Carasobarbus luteus* (Heckel, 1843) and *Capoeta trutta* (Heckel, 1843) (Cyprinidae) in the Tigris River, Turkey. Iran J. Fish. Sci. [Internet]. 2017 [cited 20 Apr. 2024]; 16(1):170–187. Available in: https://goo.su/EsZ4t

[12] Bilici S. The length–weight relationship and condition factor of two fish species *Planiliza abu* and *Silurus triostegus* from the Tigris River before the construction of the Ilisu and Cizre dams on the river. Fresenius Environ. Bull. 2021; 30(3):3032–3038.

[13] Bilici S, Kaya A, Dörtbudak M, Çiçek T, Ünlü E. Variation in the shape and size of the Tigris bream (*Acanthobrama marmid*, Heckel,1843) from the Tigris River, Türkiye attributed to seasonality, age and sex: A geometric morphometric study. Rev. Cient. FCV–LUZ. [Internet]. 2024; 34(1):e34366. doi. https://doi.org/g639fr

[14] Le Cren ED. The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). J. Anim. Ecol. [Internet]. 1951 [cited 12 Jan. 2024]; 201–219. Available in: https://www.jstor.org/stable/1540

[15] Santos MN, Gaspar MB, Vasconcelos P, Monteiro CC. Weight–length relationships for 50 selected fish species of the Algarve coast (southern Portugal). Fish. Res. [Internet]. 2002; 59(1):289–295. doi: https://doi.org/d694j2

[16] Tesch FW. Age and growth. In: Ricker WE, editor. Methods for assessment of fish production in fresh waters. Philadelphia (Pennsylvania, USA): Blackwell Scientific, International Biological Programme; 1968; 98–130 p. (IBP Handbook; 3).

[17] Uçkun AA, Gökçe D. Assessing age, growth, and reproduction of *Alburnus mossulensis* and *Acanthobrama marmid* (Cyprinidae) populations in Karakaya dam lake (Turkey). Turk. J. Zool. [Internet]. 2015; 39(1):1–14. doi: https://doi.org/nkz6

[18] Saha SN, Vijayanand P, Rajagopal S. Length–weight relationship and relative condition factor in *Thenus orientalis* (Lund, 1793) along east coast of India. Curr. Res. J. Biol. Sci. [Internet]. 2009 [cited 11 Jan. 2024]; 1(2):11–14. Available in: https://goo.su/R9sZedU

[19] Ünlü E, Balci K, Akbayin H. Some biological characteristics of the *Acanthobrama marmid* Heckel, 1843 in the Tigris River, Turkey. Turk. J. Zool. [Internet]. 1994 [cited 2 Jan. 2024]; 18(1):131–139. Available in: https://goo.su/5aorvio

[20] Başusta N, Çiçek E. Length–weight relationships for some teleost fishes caught in Ataturk Dam Lake on southeastern Anatolia, Turkey. J. App. Ichthyol. [Internet]. 2006; 22(4):279–280. doi: https://doi.org/dzjgzr

[21] Keivany Y, Mortazavi SS, Farhadian O. Age and growth of brond–snout, Chondrostoma regium in Beheshtabad river of Chaharmahal & Bakhtiari province of Iran (Teleostei: Cyprinidae). Iran J. Ichthyol. [Internet]. 2018 [cited 2 Jan. 2024]; 5(1):30–42. Available in: https://goo.su/qEXMmw

[22] Oymak SA. Atatürk Baraj Gölü'nde Yaflayan Chondrostoma regium (Heckel, 1843)'un Büyüme Özellikleri [The growth characteristics of *Chondrostoma regium* (Heckel, 1843) in Ataturk Dam Lake (Turkey)]. Turk. J. Zool. [Internet]. 2000 [cited 23 Dec. 2023]; 24(5):41–50. Turkish. Available in: https://goo.su/zzZVjLH

[23] Keivany Y, Dopeikar H, Ghorbani M, Kiani F, Paykan Heyrati F. Length–weight and length–length relationships of three cyprinid fishes from the Bibi Sayyedan River, western Iran. J. App. Ichthyol. [Internet]. 2016; 32(3):507–508. doi: https://doi.org/g639ft

[24] Parmaksız A, Oymak, A, Doğan, N, Ünlü E. Select biological characteristics of the mossul bleak *Alburnus mossulensis* Heckel, 1843 (Actinopterygii: Cyprinidae) in the Ataturk Dam Lake, Turkey. Indian J. Fish. [Internet]. 2018; 65(4):36–43. doi: https://doi.org/g639fv

[25] Birecikligil SS, Çiçek E, Öztürk S, Seçer B, Çelepoğlu Y. Length–length, length–weight relationship and condition factor of fishes in Nevşehir Province, Kızılırmak River Basin (Turkey). Acta Biologica Turcica. [Internet]. 2016 [cited 11 Jan 2024]; 29(3): 72–77. Available in: https://goo.su/RSFV

[26] İnnal D. Age and growth properties of *Carassius gibelio* (Cyprinidae) living in Aksu River Estuary (Antalya-Turkey). Rev. Hydrobiol. [Internet]. 2012 [cited 12 Jan. 2024]; 5(2):97-109. Available in: https://goo.su/S3yoTwV

[27] Bostancı D, Polat N, Kandemir Ş, Yılmaz S. Bafra balık gölü'nde yaşayan havuz balığı, *Carassius gibelio* (Bloch, 1782)'nun kondisyon faktörü ve boy-ağırlık ilişkisinin belirlenmesi. [Determination of condition factor and length-weight relationship of the crucian carp, *Carassius gibelio* (Bloch, 1782) inhabiting Bafra Fish Lake]. SDÜ Fen Edebiyat Fakültesi Fen Dergisi. 2007 [cited 12 Jan. 2024]; 2(2):117-125. Turkish. Available in: https://goo.su/5tUFi

[28] Yılmaz S, Yazıcıoğlu O, Yazıcı R, Polat N. Ladik Gölü (Samsun, Türkiye)'nde Yaşayan Havuz Balığı, *Carassius gibelio* (Bloch, 1782)'nın Kondisyon Faktörü, Boy-Ağırlık ve Boy-Boy İlişkileri [Condition factor, length-weight and length-length relationships of Prussian carp, *Carassius gibelio* (Bloch, 1782) inhabiting Lake Ladik, Samsun, Turkey]. Karadeniz Fen Bilimleri Dergisi [Internet]. 2013 [cited 25 Nov. 2023]; 3(9):72-80. Available in: https://goo.su/MwFOZ8

[29] Hashemzadeh İ, Tabatabaei SN, Mansouri A, Abdoli A, Ghalenoei M, Golzarianpour K. Length-weight relationships of *Garra rufa*, in the Tigris and Persian Gulf basins of Iran. Int. J. Aquat. Biol. [Internet]. 2015; 3(1):25-27. doi: https://doi.org/g639f2

[30] Gerami MH, Aabdollahi D, Patimar R. Length-weight, length-length relationship and condition factor of *Garra rufa* in Cholvar river of Iran. World J. Fish Marine Sci. [Internet]. 2013 [cited 20 Jan. 2024]; 5(4):358-361. doi: https://goo.su/DN4Na

[31] Oymak SA, Doğan N, Uysal E. Age, growth and reproduction of the Shabut *Barbus grypus* (Cyprinidae) in Atatürk Dam Lake (Euphrates River), Turkey. Cybium [Internet]. 2008; 32(2):145-152. doi: https://doi.org/nk26

[32] Rasheed RO. Length-weight relationships of (9) fish species from Derbendikhan Reservoir-Kurdistan region, Iraq. J. Univ. Babylon [Internet]. 2012 [cited 22 Dec. 2023]; 20(5):1434-1440. Available in: https://goo.su/XEC3lp

[33] Hashemi SAR, Mortazavi SA. Population dynamics of *Barbus grypus* (Heckel, 1843) and *Barbus barbulus* (Heckel, 1847) in Karoon River, south-west Iran. Iran. Sci. Fish. J. [Internet]. 2011 [cited 12 Jan. 2024]; 20(3):155-166. Persian. Available in: https://goo.su/pcC79

[34] Hussain NA, Al-Taee MMS, Al-Amari MJY. Some biological aspects of Shabbot *Barbus grypus* (Heckel) in Al-Hilla River/ IRAQ. Iraqi. J. Aquac. [Internet]. 2012; 9(2):143-162. Arabic. doi: https://doi.org/nk3d

[35] Uçkun AA, Gökçe D. Growth and reproduction of *Cyprinion macrostomus* (Heckel, 1843) and *Cyprinion kais* (Heckel, 1843) populations in Karakaya Dam Lake (Euphrates River), Turkey. Turk. J. Zool. [Internet]. 2015; 39(4): 685-692. doi: https://doi.org/g639f4

[36] Faghani-Langroudi H, Esmailpour-Chokami H, Eslamkhah-Taghizad MM, Rohani-Rad M, Mousavi-Sabet H. Length-weight and length-length relationships of *Cyprinion macrostomum* from the Tigris River drainage. AACL Bioflux. [Internet]. 2014 [cited 2 Jan 2024]; 7(4):234-240. Available in: https://goo.su/qW2FTY

[37] Javaheri BM, Taghavi NM, Pazira A. Length-weight relationship and condition factor of *Capoetta trutta* in Shour River downstream. Adv. Environ. Biol. [Internet]. 2012 [cited 12 Nov 2023]; 1731-1735. Available in: https://goo.su/yxLV

[38] Özcan Eİ, Serdar O. Some growth parameters of *Capoeta umbla* (Heckel, 1843) population living in the Pülümür River. Int. J. Pure Appl. Sci. [Internet]. 2021; 7(3):410-418. doi: https://doi.org/g639f5

[39] Türkmen M, Erdoğan O, Yıldırım A, Akyurt İ. Reproduction tactics, age and growth of *Capoeta capoeta umbla* Heckel 1843 from the Aşkale Region of the Karasu River, Turkey. Fish. Res. [Internet]. 2002; 54(3):317-328. doi: https://doi.org/fvzwh7

[40] Dörtbudak MY, Şevik R, Doğan N. Atatürk Baraj Gölü'nde Yaşayan Bıyıklı Balık (*Luciobarbus mystaceus* (Pallas, 1814))'ın Bazı Biyolojik Özellikleri [Some biological properties of *Luciobarbus mystaceus* (Pallas, 1814) in the Atatürk Dam Lake]. Harran Üniv. Vet. Fak. Derg. [Internet] 2012 [cited 18 Jan. 2024]; 1(2):73-83. Turkish. Available in: https://goo.su/P7rkTYs

[41] Hedayati SA, Ghafari Farsani H, Gerami MH. Length-weight relationships of two fish species from Gamsiab Reservoir, western Iran: *Alburnus mossulensis* Heckel, 1843 and *Luciobarbus esocinus* Heckel, 1843. J. Appl. Ichtiol. [Internet]. doi: https://doi.org/f79g2w

[42] Çoban MZ, Türkgülü İ, Yüksel F, Celayir Y, Yüce S, Eroğlu M, Yildiz N, Şen D. Some biological characteristics of *Luciobarbus esocinus* Heckel, 1843 living in Keban Reservoir. Turk. J. Fish. Aquat. Sci. [Internet]. 2012; 12(1):73-80 doi: https://doi.org/g6fs27

[43] Ali AM, Tomas NK. Some ecological aspects of bizz *Barbus esocinus* Heckel, 1843 (Actinopterygii, Cyprinidae) from Tigris and Euphrates rivers-Iraq. Trop. Freshw. Biol. [Internet]. 2009; 18(1):27-50. doi: https://doi.org/b3f62g

[44] Hajiahmadian M, Rabbaniha M, Ghafari Farsani H, Gerami MH, Shahbazi Naserabad S. Age, growth and spawning season of *Luciobarbus esocinus* Heckel, 1843 in Gamasiab River, Iran. Iran J. Fish. Sci. [Internet]. 2018 [cited 22 Jan 2024]; 17(1):194-207. Available in: https://goo.su/f0WNr

[45] Nikolsky GV. The ecology of fishes. 6th. ed. London: Academic Press; 1963. 353 p.

[46] Froese R. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. J. Appl. Ichtiol. [Internet]. 2006; 22(4):241-253. doi: https://doi.org/db6sns

[47] Sutton SG, Bult TP, Haedrich RL. Relationships among fat weight, body weight, water weight, and condition factors in wild Atlantic salmon parr. Trans. Am. Fish. Soc. [Internet]. 2000; 129(2):527-538. doi: https://doi.org/fjnfsp

[48] Bolger T, Connolly PL. The selection of suitable indices for the measurement and analysis of fish condition. J. Fish Biol. [internet]. 1989; 34(2):171-182. doi: https://doi.org/cjrzzb

[49] Wootton RJ. Ecology of teleost fishes. Dordrecht (Netherlands): Springer; 1990. 404 p.

[50] Weatherley AH. Growth and Ecology of Fish Populations. New York: Academic Press; 1972. 293 p.

[51] Çiçek E, Seçer B, Öztürk S, Sungur S. Age and growth of *Garra rufa* (Heckel, 1843) from Merzimen stream, Euphrates River Basin, Turkey. J. Limnol. Freshw. Fish. Res. [Internet]. 2021; 7(1):77-82. doi: https://doi.org/g639f8