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RESEARCH ARTICLE

Length-Weight Relationship and Condition Factor of Prussian Carp (*Carassius gibelio*, Bloch, 1782) from Asi River

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ABSTRACT

This study aimed to determine the length-weight relationship and condition factor of Prussian carp (*Carassius gibelio*, Bloch, 1782) from the Asi River. Samples were collected by 12-18 mm mesh sized fyke-nets between November and December 2021. Totally 88 specimens have been collected from the Turkish part of Asi River, Hatay, Türkiye. Lengths and weights ranged from 10.2 to 29.8 cm and 19.47 to 408.59 g, respectively. The b-values were calculated as 3.08 and the LWR equation was estimated as $W = 0.0138*L^{3.08}$. The Fulton's condition factor (K) and the relative condition factor (K_n) values were calculated as 1.76±0.03 and 1.01±0.01, respectively. This study provides the valuable data on the length-weight relationship and condition factors of *C. gibelio* from the Asi River. The findings of the present paper revealed that *C. gibelio* showed an isometric growth and this region is relatively suitable for the growth of this species. Therefore, these data will be a valuable background for further biological studies and local fisheries management strategies.

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Introduction

Carassius gibelio is a benthopelagic species and mainly feeds on plankton, benthic invertebrates, plant material and detritus. It has a wide distribution from European water to eastern Asia (Kottelat & Freyhof, 2007). The presence of *C. gibelio* from Turkish inland waters was reported from Gala Lake in 1988, for the first time (Baran & Ongan, 1988). Subsequently, many reports have followed from several Anatolian waters (Özcan, 2007; Yerli et al., 2014).

Asi River flows through highly populated cities before pouring its waters into the Mediterranean Sea. Therefore, it suffers from pollutants caused by human induced activities that are common in the basin such as agriculture and animal husbandry. Recent studies showed that low dissolved oxygen, organic pollution, microplastic pollution, and metal toxicity risk are major concerns for aquatic animals in the Asi River (Kılıç & Yücel, 2019; Turan et al., 2020; Kılıç et al., 2022). Since *C. gibelio* species are tolerant to low oxygen concentrations and pollution (Kottelat & Freyhof, 2007), they

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can establish an important fish stock in freshwater systems with known environmental pollution problems like the Asi River.

Several methods are used to estimate fish population parameters, and the length-weight relationship is known to be one of the most important tools for fish populations in a particular geographic region (Tesch, 1971; Seçer et al. 2021; Acarlı et al., 2022). For that reason, studies investigating the length-weight relationship of aquatic organisms are frequently updated depending on the possible spatiotemporal variations (Acarlı et al., 2022).

To date, there are various species, both native and invasive, belonging to different families in the Asi River (Demirci & Demirci, 2009; Bayçelebi, 2020). Some biological parameters of *Barbus luteus* (Gökçek & Akyurt, 2008), *Capoeta capoeta* (Demirci & Yalçın Özdilek, 2010), *Alburnus orontis*, *Chondrostoma kinzelbachi* (Özcan & Altun, 2015), *Capoeta barroisi* (Demirci & Yalçın Özdilek, 2015), *Garra rufa* (Demirci et al., 2016), *Capoeta angorae* (Alagöz Ergüden & Turan, 2017), *Anguilla anguilla* (Demirci et al., 2020), *Barbus lorteti* (Demirci & Yalçın Özdilek, 2021), *Salaria fluviatilis* (Alagöz Ergüden, 2021a), *Garra turcica* (Alagöz Ergüden, 2021b), *Clarias gariepinus* (Şimşek et al., 2022) have been assessed in previous studies. Since Cyprinidae family carries commercial importance in the Asi River (Demirci & Demirci, 2009), information regarding its population characteristics is important for the establishment of proper management strategies. Therefore, this study aimed to determine the length-weight relationship and condition factor of *C. gibelio* in the Asi River Basin.

Materials and Methods

The study was conducted in Turkish part of Asi River. The surface waters of the Asi River are shared between Lebanon, Syria, and Türkiye. Once the Asi River reaches the Turkish territory, it merges with Burç and Karasu streams and pourers to the Mediterranean Sea (Figure 1). The Mediterranean climate zone is known for hot summers and low precipitation (Kılıç & Can, 2017; Kılıç, 2018). Annual precipitation and mean temperature of basin 816 mm and 16.8 °C, respectively. The annual streamflow of the river is 1.17 km^3/year (Şimşek et al., 2022). Basin suffered from many anthropogenic influences mainly agriculture, husbandry, and urbanization (Kılıç et al., 2018; Kılıç & Yücel, 2019).

Figure 1. The location of the Asi River.

Samples were collected between November and December 2021 with 12-18 mm mesh sized fyke-nets. Total lengths (TL) and wet weights (W) were measured to the nearest 1.0 mm and 0.01 g, respectively. The LWR of *C. gibelio* was estimated with Eq. (1) suggested by Ricker (1975). The parameters were calculated by the log-transformation equation: log(W) = log(a)

+ b log(TL) where W is the weight, TL is the total length, and a and b are constants.

$$W = aL^b \quad (1)$$

Fulton (1904)'s coefficient of condition factor (K) was calculated by Eq. (2).

$$K = \frac{W}{L^3} \times 100 \quad (2)$$

In this equation, K is the condition factor, W is the total weight (g), and L is the total length (cm). Besides, the relative condition factor (K_n) was also presented using Eq. (3) [Le Cren, 1951].

$$K_n = \frac{W}{aL^b} \quad (3)$$

where K_n is the relative condition factor, a is the intercept and b is the slope derived from the LWR estimation, W is the total weight (g), L is the length (cm).

Results

This study provides LWR and condition factor of *C. gibelio* from the Turkish part of the Asi River collected between November and December 2021. A total of 88 specimens of *C. gibelio* was collected from the Asi River. The fish size ranged from 10.2 to 29.8 cm (TL) and weighed between 19.47 and 408.59 g (Figure 2). The mean TL and mean TW values of samples caught from the Asi River were calculated as 16.55±0.41 cm and 94.35±8.48 g (Table 1).

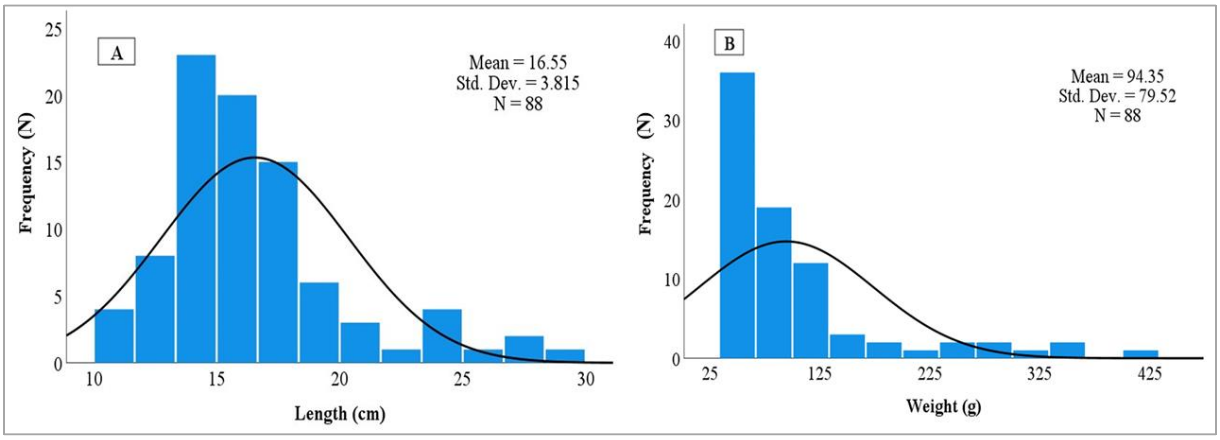

Figure 2. Frequency of lengths (A) and weights (B) of *C. gibelio* from Asi River.

The LWR of C. *gibelio* was estimated as $W= 0.0138*L^{3.08}$. The exponent of the length-weight relationship, b, showed an isometric growth (Figure 3).

Fulton's condition factor (K) and relative condition factor (K_n) values varied from 1.247 to 2.331 and from 0.717 to 1.348, respectively. The estimated mean K and K_n values were 1.759±0.025 and 1.012±0.014, respectively (Table 1).

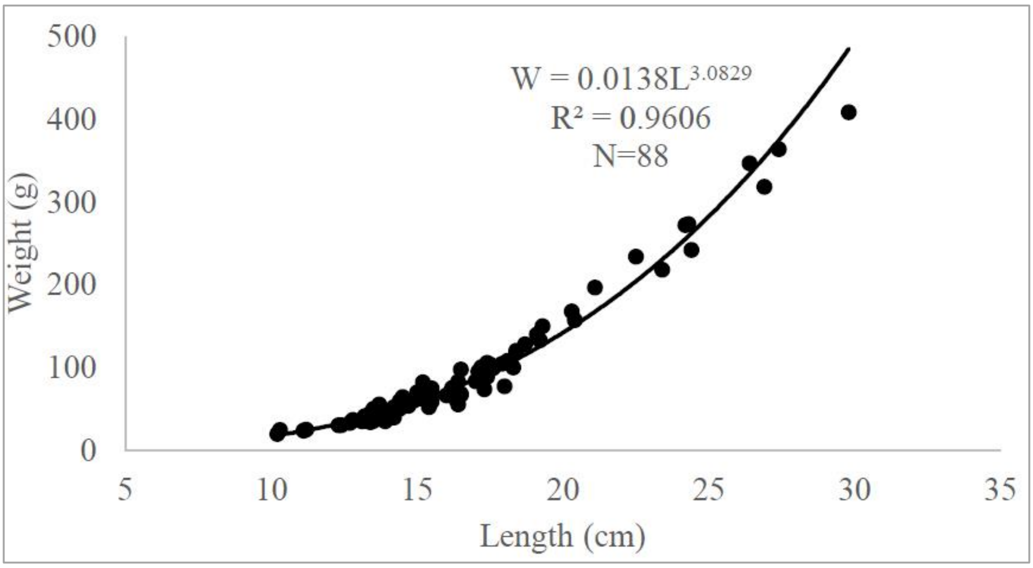

Figure 3. The length-weight relationship of *C. gibelio* collected from the Asi River during the study period.

Table 1. Some biological parameters of *C. gibelio* from Asi River.

N	Total Length (cm)		Weight (g)		a	b	r^2	SE of b	Growth Type	K		K_n	
	Range	Mean±SE	Range	Mean±SE						Range	Mean±SE	Range	Mean±SE
88	10.2-29.8	16.55±0.41	19.47-408.59	94.35±8.48	0.0138	3.0829	0.9606	0.067	I	1.25-2.33	1.76±0.03	0.72-1.35	1.01±0.01

N: Sample size, a and b: Parameters of length-weight relationships equation, r^2: Coefficient of correlation, SE: Standard error, K: Fulton's condition factor, K_n. Relative condition factor, I: Isometric growth.

Discussion

Although the Asi River is an important area in terms of species diversity, this region has important fish stock problems due to seasonal water shortages and overfishing (Demirci & Yalçın Özdilek, 2010, 2015, 2021; Demirci et al., 2020). Therefore, monitoring and protection of fish populations in this region is essential for a sustainable ecosystem and fisheries. The present study investigated the basic biological information (LWR, *K*, K_n) of *C. gibelio* in the region. Furthermore, the length-weight relationships for *C. gibelio* were compared with available literature from different regions (Table 2).

The "b" value of LWR is reported to be within the range of 2.5 to 3.5 for fish (Carlander, 1977). The "b" value estimated in this study was within the standardized range. In addition, previous studies examining LWR of *C. gibelio* from different environments also reported coherent "b" values to the previously described standards (Table 2). The "b" value is also a practical tool to determine the growth type of fish stock. In this study, the growth of *C. gibelio* was evaluated as an isometric growth, meaning that the weight gain with length was isometric. Our results are similar to those previously found by Çiçek et al. (2022) in the Asi River. Also, the growth type observed in this study is similar to previous studies in different regions of Türkiye (Table 2).

Table 2. Length-weight relationship parameters ($W=aTL^b$) of *C. gibelio* reported worldwide (G: Gender, F: Female, M: Male, A: All, N: Sample size, a: Intercept of the relationship, b: Slope of the relationship, r^2: Coefficient of correlation).

Location	G	N	a	b	r^2	Reference
Volvi Lake, Greece	A	102	0.0142	3.110	0.980	Kleanthidis et al. (1999)
Ömerli Dam Lake, Türkiye	A	730	0.0099	3.180	0.991	Tarkan et al. (2006)
İznik Lake, Türkiye	A	363	0.0084	3.250	0.989	
Lysimachia Lake, Greece	F	267	0.0660	2.580	0.800	Tsoumani et al. (2006)
Pamvotis Lake, Greece	F	494	0.0190	3.060	0.940	
	M	13	0.0440	2.780	0.970	
Chimaditis Lake, Greece	F	205	0.0600	2.740	0.880	
Kerkini Lake, Greece	F	51	0.0490	2.720	0.850	
Volvi Lake, Greece	F	50	0.0210	2.960	0.990	
Kastoria Lake, Greece	F	52	0.0260	2.890	0.970	
Vegoritis Lake, Greece	F	49	0.0090	3.250	0.960	
Trichonis Lake, Greece	F	12	0.0040	3.380	0.950	
Mikri Prespa Lake, Greece	F	18	0.2200	2.330	0.730	
Doirani Lake, Greece	F	51	0.1000	2.400	0.820	
Koronia Lake, Greece	F	51	0.1400	2.360	0.720	
Zazari Lake, Greece	F	20	0.0340	2.810	0.830	
Buldan Dam Lake, Türkiye	A	2325	0.0310	2.870	0.985	Sarı et al. (2008)
Chimaditis Lake, Greece	A	600	0.0336	2.810	0.920	Leonardos et al. (2008)
Doirani Lake, Greece	A	205	0.0137	3.059	0.989	Bobori et al. (2010)
Mikri Prespa Lake, Greece	A	49	0.0094	3.187	0.994	
Volvi Lake, Greece	A	143	0.0214	2.945	0.972	
Flanders, Belgium	A	10364	0.0107	3.183	0.990	Verreycken et al. (2011)
Danube River, Romania	A	314	0.0298	2.866	0.902	Gheorghe et al. (2012)
Anzali wetland, Iran	A	95	0.0224	2.879	0.900	Moradinasab et al. (2012)
Aksu River, Türkiye	A	128	0.0138	3.114	0.976	İnnal (2012)

Table 2. (continued).

Location	G	N	a	b	r^2	Reference
Seyitler Reservoir, Türkiye	F	123	0.0700	2.130	0.838	Bulut et al. (2013)
	M	24	0.2940	2.640	0.784	
	A	149	0.0270	2.940	0.813	
Ikizcetepeler Dam Lake, Türkiye	F	374	0.0240	2.890	0.609	Erdoğan et al. (2014)
	M	106	0.0160	2.980	0.700	
Ain Zada Reservoir, Algeria	A	93	-1.790	3.040	0.940	Mimeche and Biche (2015)
Cişmigiu Lake, Romania	A	94	0.0055	3.630	0.913	Stavrescu-Bedivan et al. (2015)
Brăneşti Lake, Romania	A	62	0.0523	2.657	0.879	
Sâi River, Romania	A	106	0.0087	3.249	0.990	
Marmara Lake, Türkiye	A	2213	0.0173	2.974	0.976	İlhan and Sarı (2015)
Seyhan River, Türkiye	F	299	0.0600	2.610	0.912	Alagöz Ergüden (2015a)
	M	18	0.1090	2.400	0.961	
	A	317	0.0670	2.570	0.927	
Seyhan Dam Lake, Türkiye	A	160	0.0519	2.650	0.933	Alagöz Ergüden (2015b)
Kızılırmak River, Türkiye	A	144	0.0230	2.860	0.850	Birecikligil et al. (2016)
Beyşehir Lake, Türkiye	A	1868	0.0175	2.959	0.925	Dereli and Dinçtürk (2016)
Madatapa Lake, Georgia	F	67	1.7900	2.990	0.930	Japoshvili et al. (2017)
	M	38	1.7300	2.930	0.950	
	A	141	-1.800	2.980	0.930	
Pantelimon II Lake, Romania	A	50	0.0396	2.758	0.844	Stavrescu-Bedivan et al. (2018)
Onaç Creek, Türkiye	A	127	0.0097	3.187	0.989	İnnal et al. (2019)
Lower Sakarya River, Türkiye	A	179	0.0264	2.870	0.970	Reis et al. (2019)
Doroudzan Dam, Iran	A	16	0.0151	3.090	0.946	Paighambari et al. (2020)
Gölcük Lake, Türkiye	A	20	0.0144	3.104	0.937	Güçlü and Küçük (2021)
Küçükler Reservoir, Türkiye	A	15	0.0015	3.808	0.864	
Buldan Reservoir, Türkiye	A	21	0.0025	3.636	0.913	
Demirköprü Reservoir, Türkiye	A	5	0.0003	4.346	0.963	
Marmara Lake, Türkiye	A	56	0.0167	3.032	0.985	
Afşar Reservoir, Türkiye	A	15	0.0115	3.123	0.963	
Karamenderes River, Türkiye	A	117	0.0079	3.255	0.990	Yalçın Özdilek and Partal (2022)
Aras River, Türkiye	A	233	0.0090	3.259	0.998	Çiçek et al. (2022)
Asi River, Türkiye	A	34	0.0140	3.070	0.863	
Batı Akdeniz, Türkiye	A	95	0.0160	3.034	0.990	
Çoruh River, Türkiye	A	38	0.0230	2.830	0.978	
Doğu Akdeniz, Türkiye	A	19	0.0110	3.156	0.998	
Fırat River, Türkiye	A	159	0.0130	3.060	0.971	
Konya, Türkiye	A	29	0.0170	2.982	0.981	
Seyhan, Türkiye	A	32	0.0090	3.171	0.949	
Asi River, Türkiye	**A**	**88**	**0.0138**	**3.082**	**0.961**	**Present study (2022)**

The wide ecological tolerance of exotic fish species causes them to multiply rapidly in inland waters (Güngör, 2012). In this regard, LWR is a valuable tool for fish stock assessment (Keyombe et al., 2015; Acarlı et al., 2022). The value of "a" in the LWR equation is expected to be between 0.001-0.050 for natural fish populations (Froese, 2006). The estimated value of "a" in this study is consistent with the expectations, as in most studies conducted in Turkish inland waters (Table 2). Çiçek et al. (2022) reported this value as 0.014 for this region. Alagöz Ergüden (2015a) reported higher "a" values for the *C. gibelio* population in the Seyhan River. Similarly, Bulut et al. (2013) reported higher "a" values for the female population of *C.*

gibelio from the Seyitler Dam Reservoir. Japoshvili et al. (2017) reported a value of -1.8 from Madatape Lake, South Georgia. The differences in the “a” value may have resulted from the sampled environment and seasonal variations (Karadurmuş, 2022).

Fulton’s condition factor (*K*) is a practical tool while evaluating the feeding and spawning activity of fish (Karadurmuş, 2022). The *K* value differs depending on the predation rate, presence of disease in the environment, food availability, and abiotic environmental factors such as pH, temperature, pollution status of the environment (Wang et al., 2017). These growth-limiting conditions cause deviations from the theoretical value of 1; whereas, favorable growth conditions cause *K* values higher than 1 (Ujjania et al., 2012). In this study, the *K* value varied between 1.25 and 2.33 indicating that *C. gibelio* grows in a harmony with the environmental conditions in the Asi River. Likewise, Çiçek et al. (2022) stated that this exotic species has been established successfully in this region and different habitats in Türkiye.

Conclusion

This study provides the valuable data on the length-weight relationship and relative condition factor of *C. gibelio* from the Asi River. The findings of the present paper revealed that *C. gibelio* showed an isometric growth and this region is relatively suitable for the growth of this species. Therefore, these data will be a valuable background for further biological studies and local fisheries management strategies. Nevertheless, more comprehensive studies are required for a better understanding of the population dynamics of the species, as researches on fish biology are essential to understand the status of fish populations in different habitats.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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