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Research Article

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Assessment of the Growth Patterns of *Luciobarbus graecus* (Teleostei) in the Upper, Middle, and Lower Basins of the Three Rivers in Türkiye

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Abstract

Objective: Following recent taxonomic revisions, *Luciobarbus graecus* (Steindachner, 1895), previously considered endemic to Greece, is now recognized as a species with a broader distribution across western Greece and western Anatolia (Türkiye). This study investigated the condition factors and length-weight relationships of *L. graecus* in Western Anatolia across various river basins and habitat types.

Materials and Methods: Using seine nets, cast nets, and electroshock devices, 241 individuals were sampled from the upper middle and lower reaches of the Büyük Menderes and Gediz rivers as well as the Kocabaş Stream.

Results: The findings showed that *L. graecus* usually exhibits isometric growth at most sampling locations, with negative allometric growth noted in the Kocabaş Stream and the upper Büyük Menderes River basin. There was a modest variation in the condition factor values between the regions, indicating that the populations were stable and generally healthy. The maximum length values found in this study are greater than those previously documented for the species. Additionally, the study offers the first information on the length-weight relationship from these particular river systems.

Conclusion: These results greatly aid in the conservation and management of *L. graecus*, which is becoming increasingly endangered due to habitat modification, pollution, hydrological changes, and invasive species. They also offer a useful baseline for upcoming ecological assessments. This study contributes to our knowledge of the indigenous ichthyofauna of Türkiye and emphasizes the significance of basin-specific population monitoring by providing insights into the species ecological performance across various freshwater settings.

Keywords Western Anatolia · Cyprinidae · river · length-weight relationships

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Introduction

Türkiye, a biogeographically significant landmass bridging three continents, exhibits exceptional ichthyofaunal diversity. Despite being composed of both Thrace and Anatolia, the richness of freshwater species predominantly arises from the Anatolian peninsula (Güçlü & Küçük, 2015). Although scientific inquiries in Anatolia date back to the latter half of the 18th century, fundamental biological data remain lacking for a substantial portion of its freshwater ichthyofauna (Güçlü & Küçük, 2015).

Until recently, *Luciobarbus kottelati* was known to inhabit the Büyük Menderes River, while *L. lydianus* was reported from the Gediz River and rivers in northwestern Anatolia (Turan *et al.*, 2008; Güçlü *et al.*, 2013; Güçlü, 2019). However, according to the study by Freyhof and Yoğurtçuoğlu (2024), *L. graecus*, a species endemic to Greece, exhibits a high degree of intraspecific variation in morphological character states and a broader overlap with *L. kottelati* and *L. lydianus* than previously documented. Furthermore, all three taxa share identical COI barcode sequences. Based on these findings, *L. lydianus* and *L. kottelati* have been recognized as junior synonyms of *L. graecus*.

Morphometric traits such as length and weight are the main parameters evaluated in population dynamics studies. The relationships between these variables provide information about growth patterns that distinguish isometric from allometric growth. Length-weight relationships (LWRs) are analytical tools used in fisheries biology and population dynamics studies that facilitate weight estimation from length measurements (Froese, 2006; Tsoumani *et al.*, 2006; Froese *et al.*, 2011). As a result, they are effective in calculating condition indices through comparisons of observed values with expected biometric values (Froese, 2006; Gaygusuz *et al.*, 2013).

This study was conducted to establish baseline data for *L. graecus*, a recently revised species distributed in Western Anatolia, and to compare the population dynamics in different river systems and regions.

Materials and Methods

The study was carried out in 7 different lotic system locations, including the upper-middle-lower basins of the Büyük Menderes River (Küfi Creek, Yenicekent DSI Regulatory, Çine Stream) and Gediz River (Derbent, Hamidiye, Turgutlu) and in the Kocabaş Stream (Çan Creek) (Table 1). Sampling in the study area was carried out using seine net, cast net and an electrofishing device between November 2020 and July 2021. In the seasonal sampling study from 7 different lotic systems, 241 *L. graecus* specimens were caught.

The Büyük Menderes River is a significant watercourse located in southwestern Türkiye. It originates near Dinar, in west-central Anatolia, and flows westward along the Büyük Menderes Graben for approximately 560 km before discharging into the Aegean Sea (Güçlü *et al.*, 2013). Located in the Aegean Region of Türkiye, the Gediz River is roughly 401 km long and has a drainage basin that is 17,500 km² in size. The Gediz is the second longest river in the area, running approximately parallel to the Büyük Menderes River to its south (Güçlü & Küçük, 2015). Northeast of Biga (Çanakkale), the Kocabaş Creek rises and joins Çan Creek, its principal tributary. After that, it travels about 80 km via the districts of Çan and Biga until emptying into the Marmara Sea to the south of Karabiga District (Güçlü, 2019).

Due to heavy industrial operations, unchecked urban growth, and intensive agricultural use, the three river basins examined in this study have recently been subjected to a growing number of environmental stresses. Furthermore, the ecological health of these river systems is adversely affected by pollution from sand-gravel quarries and the leather industry, which leads to the loss of the formerly abundant and varied fish species (Güçlü *et al.*, 2013; Güçlü & Küçük, 2015; Güçlü, 2019).

Definitions of the species nomenclature are given according to Freyhof and Yoğurtçuoğlu (2024) (Figure 1). Specimens were measured to the nearest 0.1 cm total length and weighted to the nearest 0.01 g total weight. To construct the length-frequency distribution, the total length (TL) data of all fish specimens were grouped into class intervals. The class width (h) was calculated by dividing the range of observed lengths by the number of class intervals (k) using the following formula:

$h = (X_{max} - X_{min}) / k$, where X_{max} and X_{min} represent the maximum and minimum observed standard lengths, respectively, and k is the number of class intervals. The number of intervals was determined according to Sturges' formula based on the sample size (n): $k = 1 + 3.22 \times \log_{10}(n)$. This method allows for a balanced representation of the dataset by minimizing the oversimplification or excessive fragmentation of the frequency distribution (Sturges, 1926; Zar, 1999).

Table 1
Sampling points in the study area

Lokality	Altitude	Coordinates
Büyük Menderes River		
Küfi Creek (Denizli)	891 m	38°22´07.46´´N, 29°50´52.77´´E
Yenicekent DSI Reg. (Denizli)	159 m	38°02´15.45´´N, 28°57´47.50´´E
Çine Stream (Aydın)	29 m	37°45´48.27´´N, 27°50´02.74´´E
Gediz River		
Derbent Creek (Kütahya-Manisa)	580 m	38°46´39.14´´N, 29°12´41.53´´E
Hamidiye (Kula-Manisa)	300 m	38°00´11.08´´N, 28°36´12.48´´E
Turgutlu (Manisa)	33 m	38°36´42.54´´N, 27°34´37.37´´E
Kocabaş Stream		
Çan Creek (Çanakkale)	83 m	40°00´02.30´´N, 26°59´ 30.51´´E

The relation of weight to total length was established using the exponential regression equation $W = a.\ TL^b$, where W is the body weight in g, TL is the total length in cm, "*a*" is the intercept and "*b*" is the regression coefficient (Ricker, 1975). The statistical significance level of the coefficient of determination (R^2) and 95% confidence intervals (95% CI) of *b* was also estimated (Zar, 1999). Fulton's coefficient of the condition factor was calculated by $Cf = (W/TL^3) \times 100$ (Sparre & Venema, 1992). The one-way ANOVA test was used to examine group differences after the condition factor data's normal distribution and variance homogeneity were examined (Zar, 1999). The significance level was set at 5% ($p < .05$).

Results and Discussion

Table 2 presents the ranges of the total length (TL) and weight (W), the parameters *a* and *b*, the 95% confidence intervals for *b*, the regression coefficient (R^2), and the condition factor values. In this study, length–weight relationship (LWR) parameters and condition factor values were calculated for *Luciobarbus graecus* (under its revised taxonomic name) for the first time. For the *L. graecus* population from the Gediz River, a new maximum total length and weight (36.38 cm and 667.4 g, lower basin: Turgutlu) exceeding previous records in the literature was determined.

The condition factor values were found to range between 1.19 and 1.32. One-way ANOVA results showed no significant differences in condition factor values among the upper, middle, and lower basin sections of the Büyük Menderes River ($F(2,113) = 2.10$, $p = .127$) and the Gediz River ($F(2,95) = 2.28$, $p = .108$) (Table 2).

The study by length classes (Figure 2) revealed structural disparities in fish populations across three distinct water bodies: the Büyük Menderes River, Gediz River, and Kocabaş Stream. In the Gediz River, a significant individual density of 30% to 50% was noted in the lower length classes (9.8 and 12.97 cm), suggesting a predominance of juvenile individuals in the population and likely a high reproductive success. In contrast, the greatest density was seen in the medium length classes, specifically at 16.14 cm, in the Büyük Menderes River, comprising nearly 38%. This

Figure 1
L. graecus, a- Kocabaş Stream, Çan-Çanakkale, 191 mm standard length; b- Gediz River, Hamidiye, Kula-Manisa, 108 mm standard length; c- Büyük Menderes River, Çine Stream, Çine-Aydın, 201 mm standard length



Table 2
Length-weight relationship parameters of L. graecus in Western Anatolia

Locality	n	TL	W	*a*	*b*	95% CI-*b*	*p*	R^2	Cf
Büyük Menderes River									
Küfi Creek (upper basin)	30	8.22-17.62	7.56-56.21	0.0209	2.797	2.647-2.891	<.001 (-A)	0.9942	1.25
Yenicekent DSİ Reg. (middle basin)	41	9.78-29.88	12.4-359.81	0.0123	3.013	2.924-3.101	is (I)	0.9931	1.28
Çine Stream (lower basin)	46	9.74-27.24	12.38-283.47	0.0113	3.029	2.930-3.112	is (I)	0.9897	1.22
Büyük Menderes River (whole basin)	117	8.22-29.88	7.56-359.81	0.0130	2.984	2.789-3.214	is (I)	0.9935	1.25
Gediz River									
Derbent Bridge (upper basin)	34	8.52-26.3	7.01-23.25	0.0161	2.913	2.754-3.242	is (I)	0.9985	1.28
Hamidiye Bridge (middle basin)	46	8.56-25.46	7.04-23.94	0.0116	3.028	2.941-3.108	is (I)	0.9892	1.25
Turgutlu (lower basin)	18	10.67-36.38*	15.3-667.4*	0.0111	3.068	2.899-3.111	is (I)	0.9972	1.32
Gediz River (whole basin)	98	8.52-36.38	7.01-667.4	0.0122	3.05	2.974-3.128	is (I)	0.9837	1.27
Kocabaş Stream									
Çan Stream (main stream)	26	10.01-23.31	12.99-147.89	0.0170	2.860	2.687-3.128	is (I)	0.9975	1.19

n: number of individuals, TL: total length (mm), W: weight (g), Cf: Fulton's coefficient, *new maximum length and weight

indicates comparatively advantageous growth conditions in the river, a robust middle-aged demographic, and a sustainable population framework. A high individual proportion of almost 55% in the larger medium length classes (19.31 cm) was observed in the Kocabaş Stream; this could indicate that individual growth rates differ or that fishing pressure is lower in this ecosystem. The percentage of individuals in the larger length classes (22.48 cm and above) remained below 10% in all three bodies of water, while the Büyük Menderes and Kocabaş streams had comparatively more individuals in these classes. Ecological elements such as habitat diversity, food resource availability, water quality, and human influences probably cause these variations.

According to Tesch (1971), the values of *b* range between 2 and 4 and mostly fall within the expected range of 2.5–3.5. The length-weight relationship parameters are influenced by various factors such as season, sample size, habitat, gonadal maturity, sex, and stomach content (Bagenal & Tesch, 1978). As shown in Table 2 and Figures 3, 4, 5, the *b* values in this study ranged from 2.79 to 3.06. For all species, the *b* parameter was confirmed to fall within the expected range of $2.5 < b < 3.5$ (Froese, 2006). Positive or negative allometry indicates a relatively more rounded or slender body shape, respectively, while isometric growth implies proportional growth in all dimensions (Jobling, 2008). The *b* values ranged between 2.91 and 3.06 for the Gediz River population, 2.79 and 3.02 for the Büyük Menderes River population, and was found to be 2.86 for the Kocabaş Stream population. In this study, *b* values were found to increase progressively toward the downstream sections of the river basins (Table 2, Figures 3, 4,

Figure 2
Total length in the frequency distributions of L. graecus in Western Anatolia

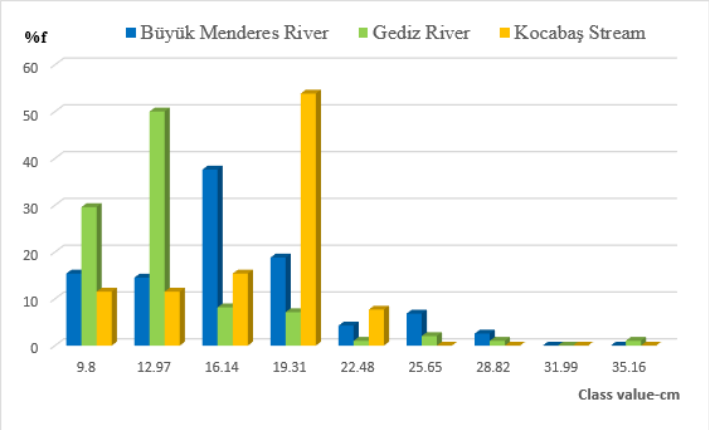


Figure 3

Length–weight relationships of the L. graecus population in the Büyük Menderes River

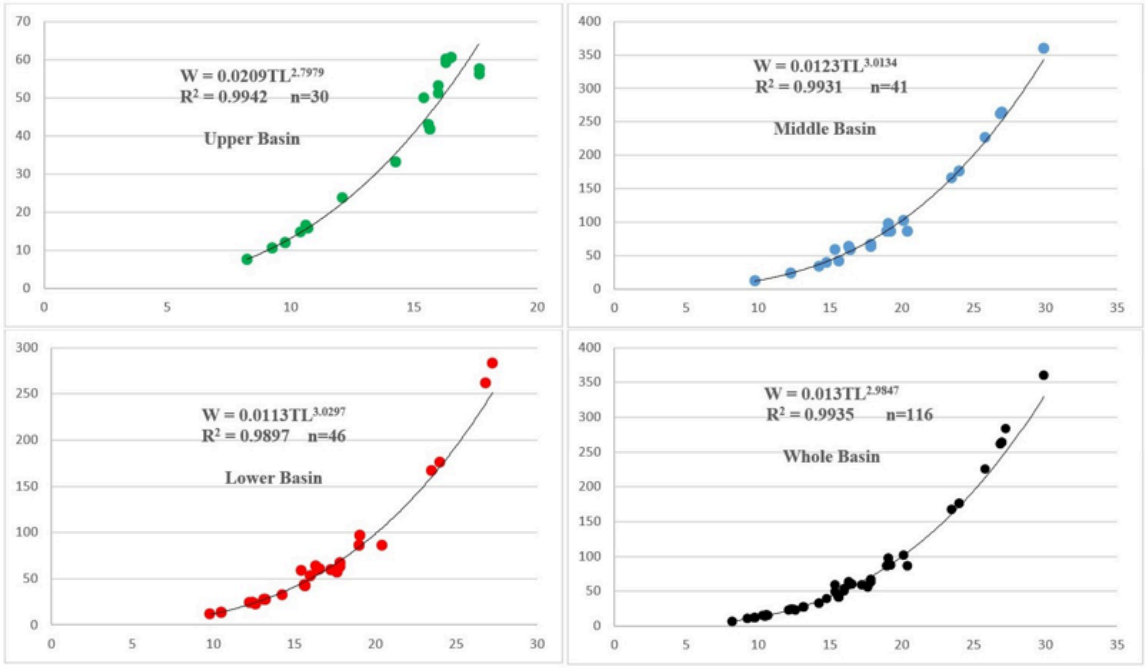
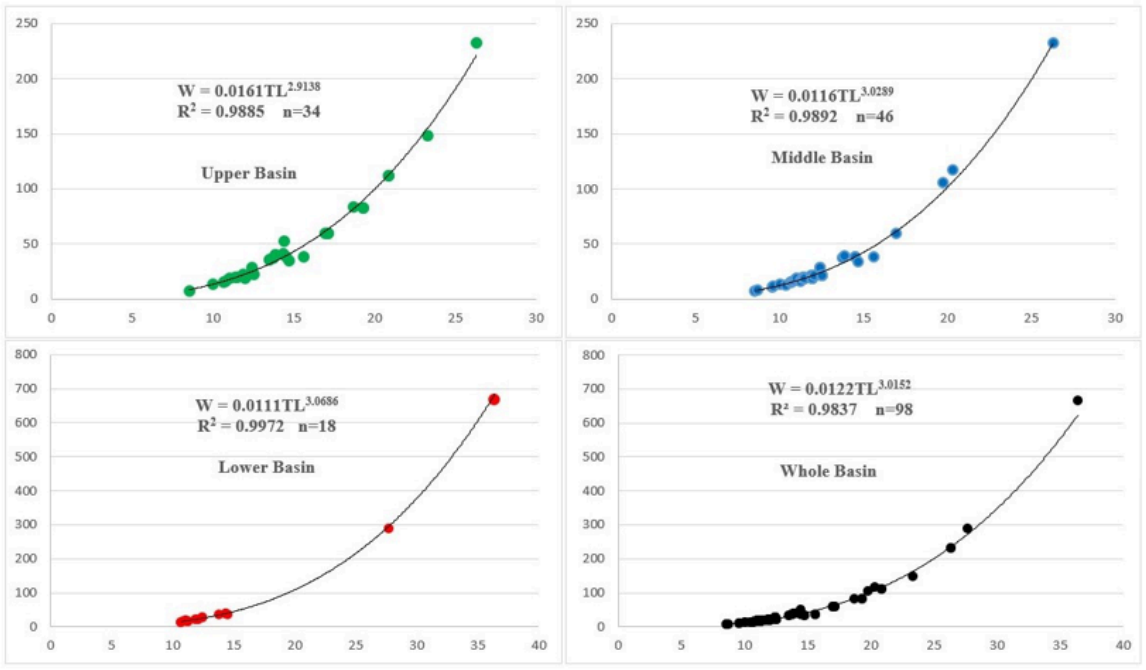


Figure 4

Length–weight relationships of the L. graecus population in the Gediz River



5). This trend may be associated with ecological gradients along the river continuum, including factors such as temperature, productivity, or reduced hydrodynamic stress in the lower reaches, which can promote more favorable growth conditions. Because we sampled the Kocabaş Stream population from only one sub-basin section, it was not possible to assess such variation.

The regression coefficient (R^2) between length and weight was found to be between 0.98 and 0.99 for all populations. No differences were observed in the regression coefficient values among the upper, middle, and lower sections of the river basins (Table 2, Figures 3, 4, 5).

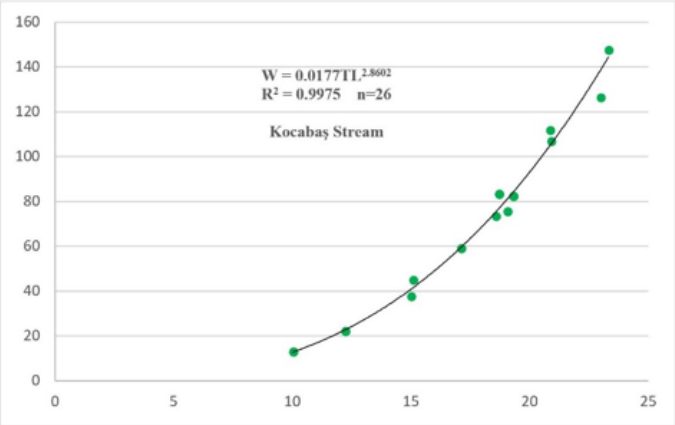
The comparison of the values obtained in this study with other limited studies conducted in the basin is presented

Table 3
Comparison of the length-weight relationship parameters of L. graecus in Western Anatolia reported by different studies

Species	Locality	Ref.	n	TL	W	*a*	*b*	R^2
L.lydianus	Afşar reservoir	1	27	13.57-25.26	26.05-182.45	0.0134	2.9266	0.9761
L.lydianus	Demirköprü reservoir	1	14	9.53-11.03	9.12-14.20	0.0148	2.8459	0.9506
L.kottelati	Kamış Creek	2	96	5.70-13.50	2.35-26.19	0.0170	2.7960	0.9890
L.kottelati	Adıgüzel reservoir	3	144	13.20-32.30	40.10-572.70	0.0099	3.1380	0.9870

References: 1- Güçlü & Küçük, 2021; 2- Gaygusuz *et al.*, 2013; 3- Başıaçık *et al.*, 2012

Figure 5
Length–weight relationships of the L. graecus population in the Kocabaş Stream



in Table 3. It was observed that the values obtained in this study are similar to those reported in previous studies. Minor differences in *b* values may be attributed to factors influencing fish growth, such as the lentic/lotic nature of habitats in other studies, sample size, sampling time, sampling methods, water quality, and nutrient availability (Sparre *et al.*, 1989).

Conclusion

This study presents the first detailed evaluation of the length–weight relationship (LWR) parameters and condition factor values for *L. graecus* populations in the Gediz, Büyük Menderes rivers and Kocabaş Stream basins. The newly recorded maximum total length in the Gediz River highlights the ecological significance of these habitats.

The dominance of small and young individuals in both river populations indicates that there is reproduction in the populations, while at the same time it also indicating possible imbalances in the age structure affected by environmental pressures. The consistency of the condition factor values in different river sections indicates a stable physiological status despite spatial variation.

According to the study findings, *L. graecus* populations in the 3 river systems generally show isometric growth, representing developing populations. The observed increase in the b parameter from the upper to the lower river basin may reflect ecological gradients such as temperature and productivity that support growth; however, further research is needed to elucidate the reasons. In the study, *L. graecus* habitats face several important anthropogenic pressures, including water pollution, habitat loss-fragmentation, rehabilitation of stream beds, water and gravel abstraction from habitats, and introduction of non-native fish species. These pressures may adversely affect the reproductive activities of older and larger individuals, as well as the juvenile fish, particularly those in the 0+ to 1+ age groups. In the three different river systems studied, continuous monitoring and protection efforts are needed to preserve the population structure and ecological integrity of *L. graecus*. At the same time, this study contributes to the database of the length-weight relationships of freshwater fish in Türkiye and forms a solid base for future research.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of the Isparta University of Applied Sciences Local Ethics Committee for Animal Experiments (Date: 12.03.2020, No: 001).

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Author Contributions: Conception/Design of Study-S.S.G.; Data Acquisition-S.S.G., Z.G.;Data Analysis/Interpretation-S.S.G., Z.G.; Drafting Manuscript-S.S.G.; Critical Revision of Manuscript-S.S.G., Z.G.; Final Approval and Accountability-S.S.G., Z.G.; Technical or Material Support-S.S.G., Z.G.

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References

Bagenal, T.B., & Tesch, F.W. (1978). Age and growth. In: Bagenal TB, editor. Methods for assessment of fish production in fresh waters. 3rd ed. IBP Handbook No. 3, Oxford: Blackwell Science Publications. p. 101–136.

Başıaçık, S., Sarı, H.M., İlhan, A., & Ustaoğlu, M.R. (2012). Adıgüzel Baraj Gölü (Denizli) bıyıklı balık (*Luciobarbus kottelati* Turan, Ekmekci, İlhan & Engin, 2008) populasyonunun bazı büyüme özellikleri. *Journal of FisheriesSciences.com*, *6*(1), 32-38.

Freyhof, J., & Yoğurtçuoğlu, B. (2024). *Luciobarbus lydianus* and *L. kottelati*, two synonyms of *L. graecus* (Teleostei: Cyprinidae). *Zootaxa, 5415*(3), 466–476. https://doi.org/10.11646/zootaxa.5415.3.6

Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *J Appl Ichthyol*, *22*, 241–253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

Froese, R., Tsikliras, A.C., & Stergiou, K.I. (2011). Editorial note on weight–length relations of fishes. Acta *Ichthyol Piscat*, *41*(4), 261–263. https://doi.org/10.3750/AIP2011.41.4.01

Gaygusuz, Ö., Aydın, H., Emiroğlu, Ö., Top, N., Dorak, Z., Gaygusuz, Ç.G., Başkurt, S., & Tarkan, A.S. (2013). Length–weight relationships of freshwater fishes from the western part of Anatolia. Turkey. *J Appl Ichthyol*, *29*, 285–287. https://doi.org/10.1111/jai.12015

Güçlü, S.S., Küçük, F., Ertan, Ö.O., & Güçlü, Z. (2013). (2013). The Fish fauna of the Büyük Menderes River (Turkey): Taxonomic and zoogeographic features. *Turkish Journal of Fisheries and Aquatic Sciences*, *13*, 685–698.

Güçlü, S.S., & Küçük, F. (2015). The ichthyofauna of Gediz River Turkey taxonomic and zoogeographic features. *Annu Res Rev Biol, 6*, 202–214. https://doi.org/10.9734/arrb

Güçlü, S.S. (2019). *Investigation of taxonomic features of Barbus and Luciobarbus (Pisces: Cyprinidae) genera in West Anatolia*. Ph. D. Thesis, Isparta Applied Science University, Isparta, 127 pp.

Güçlü, S.S., & Küçük, F. (2021). Length-Weight relationship of 15 different freshwater fish species in the Gediz River basin (Turkey) lentic system. *Journal of Limnology and Freshwater Fisheries Research*, *7*, 166–170. https://doi.org/10.17216/limnofish.798820

Jobling, M. (2008). Environmental factors and rates of development and growth. In: Hart PJ, Reynolds, JD, editör. *Handbook of fish biology and fisheries*, Vol. 1: Fish biology. Oxford: Blackwell Publishing Ltd. p. 97–122.

Ricker, W.E. (1975). Computation and interpretation of biological statistics of fish populations. New Jersey, the USA: The Blackburn Press 400 p.

Sparre, P., & Venema, S.C. (1992). Introduction to Tropical Fish Stock Assasment, Part I, FAO Fisheries Technical Paper 306/1, Rome, 376 pp.

Sparre, P., Ursin, E., & Venema, S.C. (1989). *Introduction to tropicalfish stock assessment*. Part 1. Manual. FAO Fisheries Technical Paper No:306.

Sturges, H. A. (1926). The choice of a class interval. *Journal of the American Statistical Association*, *21*(153), 65–66. https://doi.org/10.1080/01621459.1926.10502161

Tesch, F.W. (1971). Age and growth. In: Ricker WE., editor. *Methods for assessment of fish production in fresh waters*. Oxford: Blackwell Scientific Publications. p. 99–130.

Tsoumani, M., Liasko, R., Moutsaki, P., Kagalou, I., & Leonardos, I. (2006). Length–weight relationships of an invasive cyprinid fish (*Carassius gibelio*) from 12 Greek lakes in relation to their trophic status. *J Appl Ichthyol, 22*, 281–284. https://doi.org/10.1111/j.1439-0426.2006.00768.x

Turan, D., Ekmekçi, F.G., İlhan, A., & Engin, S. (2008). *Luciobarbus kottelati*, a new species of barbel (Teleostei: Cyprinidae) from the Büyük Menderes River, Turkey, with rediagnose of *L. lydianus*. *Zootaxa*, *1824*(1), 35–44. https://doi.org/10.11646/zootaxa.1824.1.4

Zar, J.H. (1999). *Biostatistical analysis*. 4th edn. NJ, USA: Prentice Hall, Upper Saddle River.