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An ichthyofaunal amendment with the length-weight relations and condition factors of some endemic and invasive freshwater fishes from Western Anatolia

by

Irmak Kurtul[1,2,*], Cüneyt Kaya[3], Arda Şen[1], Ceylin Özcan[1], Deniz Ercivan[1], Kaan Demiral[1], Melike Güngör[1], Ali İlhan[1], Hasan Musa Sarı[1]

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[1]*Marine and Inland Waters Sciences and Technology Department, Faculty of Fisheries, Ege University, İzmir, Türkiye*

[2]*Department of Life and Environmental Sciences, Bournemouth University, Poole, Dorset, United Kingdom*

[3]*Faculty of Fisheries, Recep Tayyip Erdoğan University, 53100 Rize, Türkiye*

* Corresponding author: *irmak.kurtul@gmail.com*

Abstract

In the scope of this study, fish fauna of Küçük Menderes River and its tributaries, updated with the comparison of the recent ichthyofaunal studies, as well as the length-weight relations (LWR) and condition factors (CF) were estimated for 7 freshwater fish species belonging to six families from the river basin: endemic *Oxynoemacheilus eliasi*, *Cobitis fahireae*; invasive, *Carassius gibelio*, *Atherina boyeri*, transloce *Perca fluviatilis* and the native *Squalius fellowesii*, *Cyprinus carpio*. The fish samples were collected with various fishnets and DC electro-fishing devices from six stations in 2018 and 2019. The LWR of the fishes was studied based on 379 specimens. The estimated values of parameter b ranged from 2.884 (*A. boyeri*) to 3.176 (*C. fahireae*). The coefficient of determination (R2) was changed between 0.792 to 0.980 for all sampling localities. In the study, Fulton's condition factor ranged between 0.391 (*S. fellowesii*) to 3.080 (*S. fellowesii*); the relative condition factor ranged between 0.346 (*O. eliasi*) to 2.746 (*S. fellowesii*), respectively. This research is anticipated to contribute valuable insights for the conservation of the species, while also furnishing essential data to inform future fisheries management studies in the region.

Key words: regression, slope value, Küçük Menderes River, growth types

1. Introduction

The Küçük Menderes River (Western Anatolia) drainage has an agricultural character, and this area covers almost half of the river basin (Aksoy 2020). As this kind of agricultural area needs to be irrigated regularly, the river basin is under pressure. Otherwise, the area has been urbanized, and there are many industrial facilities that need water actively (Eris et al. 2020). The water needed is mainly supplied from groundwater (Yağbasan 2016). The importance of the river basin has been studied in terms of water management by state-owned organizations (TUBITAK 2010). In recent years, there have been many changes in the basin, where anthropogenic pressure is extremely high. It has been observed that – depending on human activities in terms of agricultural, fishing, industry and land uses – aquatic habitats have changed.

Türkiye is remarkable in terms of having extraordinarily rich natural wildlife, and there are many freshwater fish species known as endemic (Freyhof et al. 2014; Çiçek et al. 2018). Endemic species are vulnerable for native fish fauna (Crivelli 1995). The invasion of alien species have been increasing, and this affects the freshwater wildlife (Tarkan et al. 2015) together with the main anthropogenic pressures such as degradation, pollution, habitat loss, and excessive water extraction (Fricke et al. 2007).

Squalius fellowesii (Günther 1868) is one of the common species that is endemic to the Bakırçay, Gediz, Küçük Menderes, Büyük Menderes, Madra, Dalaman, and Eşen rivers in the Western part of Anatolia (Özuluğ, Freyhof 2011). There are some local studies for these species, which are related to its distribution and some biological features (Şaşı, Balık 2003; Balık et al. 2004; Şaşı 2004; Koç et al. 2007). Virtually no information has been made available recently except for a few studies on the distribution and ecology of freshwater fish (Özdemir et al. 2015) and some biological treatments as growth and life history traits, including the *S. fellowesii* (Gianetto et al. 2012; Top et al. 2016).

The family Nemacheilidae is very diverse (Kottelat 2012; Çiçek et al. 2018, 2020; Jouladeh-Roudbar et al. 2020). It is distributed in the freshwaters in Asia, Europe, and north-eastern Africa (Nelson et al. 2016). The genus *Oxynoemacheilus* is the most species-rich genus of the family, containing 61 species which inhabit the Middle East, and *Oxynoemacheilus eliasi* is one of the newest members of it, that has been described from the Gediz, Küçük Menderes and Tahtalı River basins in Western Anatolia (Yoğurtçuoğlu et al. 2022). Because the genus is very diverse, taxonomic studies are still trying to distinguish the genus (e.g., Freyhof et al. 2019, 2021; 2022; Turan et al. 2019; Kaya et al. 2020). In recent studies, 34 species of *Oxynoemacheilus* in Türkiye (Çiçek et al. 2022) and 15 species of *Oxynoemacheilus* in Iran (Mouludi-Saleh et al. 2023) were investigated in terms of LWRs and CF.

The genus *Cobitis* is also an extraordinarily rich group in terms of endemism and diversity. Freyhof et al. (2018) recognised 30 species in Western Asia. In the following years, another new species was described in Dalaman River (Eagderi et al. 2022). However, LWRs studies on *Cobitis* species have been very limited.

To manage the conservation of endemic species, the biological and ecological data should be available for every species. Knowledge of these kinds of parameters are basic requirements; however, not enough data is available for all three – *S. fellowesii, O. eliasi,* and *C. fahireae* – in their native distribution ranges in Western Anatolia.

The length-weight relationship (LWR) is used to investigate age structures, find growth rates, and for many other parameters. The LWRs provide fundamental data for many kinds of fishery research (Sparre, Venema 1998; Froese 2006). The LWRs allow us to compare given populations among different regions (Petrakis, Stergiou 1995; Froese 2006). The fish morphology ensures the opportunity to understand the population structures in different aquatic areas (Moutopoulos, Stergiou 2002; Sangun et al. 2007), and these kinds of data can easily be applied to fisheries research studies.

To take an action for the conservation for freshwater fishes from both anthropogenic pressure, and invasive species, the number of scientific studies on the fish should be increase. Therefore, a perceived deficiency exists in the fundamental parameters characterizing populations. The objective of this study is to explore growth patterns in *Oxynoemacheilus eliasi* and *Cobitis fahireae*, both endemic species, as well as the invasive fish species *Carassius gibelio* and *Atherina boyeri*. Additionally, the investigation extends to the translocated species *Perca fluviatilis* and native members *Squalius fellowesii* and *Cyprinus carpio*, sourced from various streams and lakes across Western Anatolia. To this end, we recorded LWRs of the species from some Western Anatolia water resources in the Küçük Menderes River basin.

2. Materials and methods

2.1. Study Area

Küçük Menderes River drainage area is approximately 3225 km^2. The river is 140 km long up to where it meets the sea (Saraçoğlu 1990). The river bed

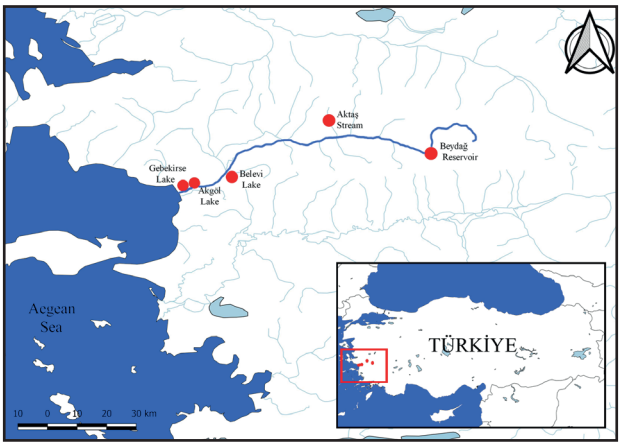

Figure 1

Sampling sites in the study area

has a very narrow character, and its gradient decreases as it reaches the plain downstream in the western part from the mountain area upstream in the eastern part. The river drainage shows characteristics of the Mediterranean climate, as winters are warm and rainy while summers are hot and dry (Peel et al. 2007).

In the scope of the study, to determine the fish fauna of the river drainage, the sampling was conducted seasonally at 21 stations (15 lotic and 6 lentic water resources) from the source to downstream in 2018 and 2019 (Figure 1 & Figure 2). But because of the lack of sampling of the size of the fish, just one lotic and 4 lentic water resources' fishes were examined in the present study. The fish sampling was investigated from Akgöl, Gebekirse, and Belevi (Selçuk/İzmir), Beydağı Reservoir (Beydağ/İzmir), and Akçay Stream (Ödemiş/İzmir) (Figure 2). The map (Figure 1) was created using the Qgis v. 2.6.1-Brighton software.

2.2. Sampling procedure and sampling period

A total of 379 specimens of freshwater fish species were collected from the Küçük Menderes River drainage, Western Anatolia. In the sampling carried out in seasonal periods, a Samus 725G model electro-shocker was used in lotic habitat, and standard nets were used in accordance with the criteria of "TS-EN 14757 Water Quality-Taking fish samples with dense mesh nets with changing meshes" in lentic habitats. After anaesthesia, the fish were preserved in 5% formaldehyde and stored in 70% ethanol.

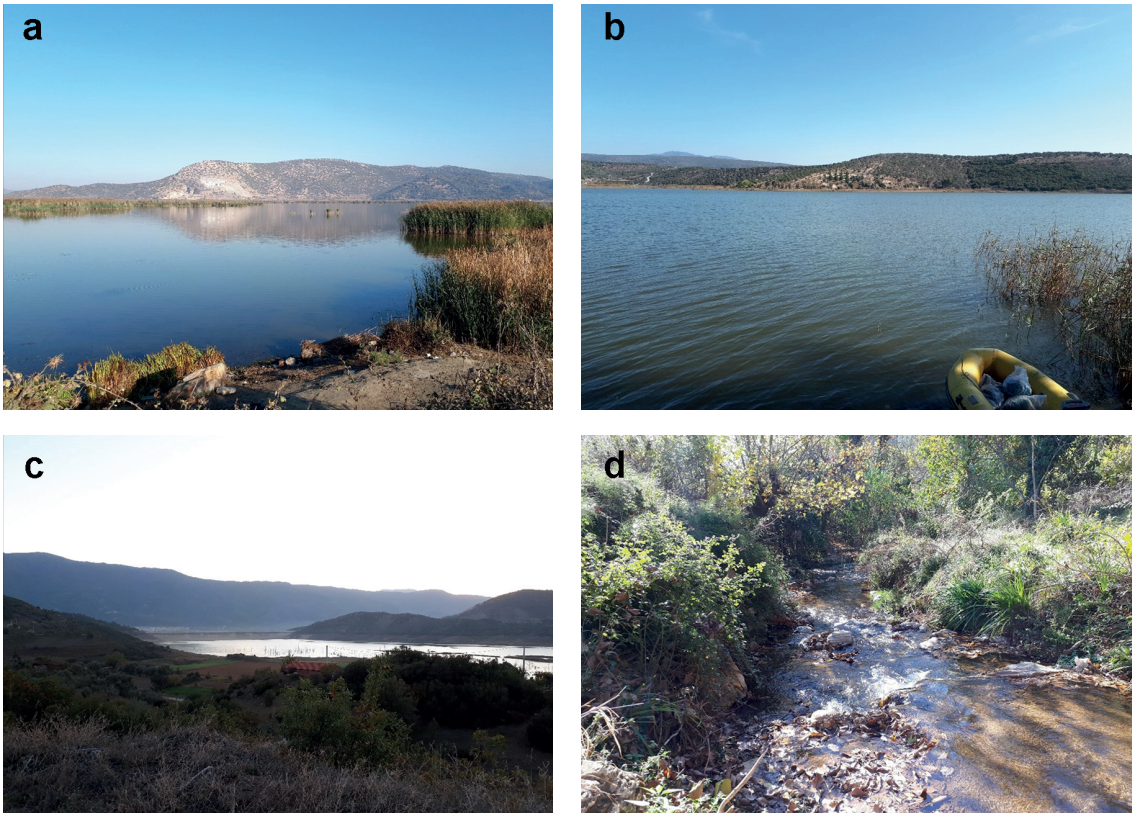

Figure 2

Some of the sampling sites in the Küçük Menderes catchment: a. Lake Belevi; b. Lake Gebekirse; c. Beydağ Reservoir; d. Aktaş Stream.

2.3. Laboratory process and analysis

The identification of the species followed Freyhof et al. (2018), Bayçelebi (2019), İlhan et al. (2021) and Yoğurtçuğlu et al. (2022)(Table 1). Due to unespied sexual dimorphism in all the fish specimens, the LWRs parameters were calculated for all specimens. In the laboratory, the total length (*L*) and total weight (W) of each individual were determined using a digital calliper to ± 0.1 cm, and ± 0.01 g, respectively. Regression analysis was used to determine the relationship between the total length and weight of the individuals. For the regression, the equation:

$$W = aL^b$$

was used (Ricker 1973). In the present formula, *W* Indicates the total weight (g), *L* shows the total length (cm), and *a* (intercept) and *b* (slope) are the regression constants (Zar 1999). The standard error of *b* were estimated in the analysis. Before determination of the LWRs equality, the coefficient of determination (R^2) was calculated (Zar 1999), and a correlation coefficient significance control test was applied. The student *t*-test was applied to data to determine the growth types of the individuals (Pajuelo, Lorenzo 1998). In the study to determine the type of growth, the equation:

$$t_c = \frac{b-3}{SE_{.}}$$

was used (Sokal, Rohlf 1987). In the equation, the following symbols were used: t_c; *t*-test value, *b*: slope and $se_{(b)}$: the standard error of the slope. In the study, Fulton's condition factor, relative condition factor, and mean condition factor were estimated by the following equalities $K_F = 100WL^{-3}$, $K_R = W(aL^b)^{-1}$, $K_M = 100aL^{b-3}$, respectively (Froese 2006). All statistical analyses were performed in MS Excel 2016.

3. Results

In the scope of this study, seven species (*Oxynoemacheilus eliasi, Cobitis fahireae, Carassius gibelio, Cyprinus carpio, Atherina boyeri, Squalius fellowesii, Perca fluviatilis*) belonging to six families were studied.

The present research provides the length and weight distribution, LWRs and CF of the 7 species. The specimens` length and weight data with their standard error were given for the study areas (Table 2). The descriptive statistics of length and weight with the parameters of the LWR; regression parameters *a* and *b*, the standard error of *b*, correlation coefficient (r) and type of growth for the studied species were also given (Table 3).

The endemic species of the river, *O. eliasi* and *C. fahireae* are small sized fish. *O. eliasi* (Figure 3, lower side) maximum length and weight were found for Aktaş Stream (L_{max} = 7.50 cm, W_{max} = 3.75 g). In a further endemic species *C. fahireae*`s (Figure 3, upper side) the

Table 1

Taxonomic updated fish species of Küçük Menderes River and its drainage, based on previous records

No	Saç et al. (2021)*	İlhan et al. (2021)**	Current Taxonomic Status
1	*Anguilla anguilla*	*Anguilla anguilla*	*Anguilla anguilla*
2	*Atherina boyeri*	*Atherina boyeri*	*Atherina boyeri*
3	*Cobitis fahireae*	*Cobitis fahireae*	*Cobitis fahireae*
4	-	-	*Cobitis afifeae*
5	*Barbus pergamonensis*	-	*Barbus pergamonensis*
6	-	*Luciobarbus lydianus*	*Luciobarbus lydianus*
7	*Carassius gibelio*	*Carassius gibelio*	*Carassius gibelio*
8	*Cyprinus carpio*	*Cyprinus carpio*	*Cyprinus carpio*
9	*Knipowitschia caucasica*	-	*Knipowitschia caucasica*
10	*Knipowitschia ricasolii*	*Knipowitschia ricasolii*	*Knipowitschia ricasolii*
11	*Alburnus demiri*	-	*Alburnus demiri*
12	*Petroleuciscus smyrnaeus*	*Petroleuciscus smyrnaeus*	*Petroleuciscus ninae*
13	*Squalius kosswigi*	*Squalius fellowesii*	*Squalius kosswigi*
14	*Chelon aurata*	*Chelon auratus*	*Chelon aurata*
15	*Chelon ramada*	*Chelon ramada*	*Chelon ramada*
16	*Oxynoemacheilus germencicus*	*Oxynoemacheilus theophilii*	*Oxynoemacheilus eliasi*
17	*Perca fluviatilis*	*Perca fluviatilis*	*Perca fluviatilis*
18	*Gambusia holbrooki*	*Gambusia holbrooki*	*Gambusia holbrooki*
19	*Syngnathus abaster*	-	*Syngnathus abaster*

The species were recorded from subbasin of the river* and those were based on previous literature** were excluded.

Table 2

The length and weight distribution, mean length and weight and their standard errors of fish species

Locality	Species	n	L_{min}	L_{max}	L_{mean} ± SE	W_{min}	W_{max}	W_{mean} ± SE
Aktaş Stream	*Squalius fellowesi*i	188	3.00	17.00	7.28 ± 0.258	0.28	58.27	7.72 ± 0.777
Beydağ Reservoir	*Perca fluviatilis*	42	6.40	20.50	7.55 ± 0.394	3.36	90.00	7.94 ± 2.591
Aktaş Stream	*Oxynoemacheilus eliasi**	25	3.40	7.50	5.09 ± 0.290	0.32	3.75	1.35 ± 0.204
Akgöl Lake	*Cobitis fahireae**	5	3.00	7.00	6.06 ± 0.690	0.16	2.36	1.79 ± 0.370
Belevi Lake	*Cyprinus carpio*	10	13.50	22.20	17.18 ± 0.861	39.98	197.43	104.24 ± 15.923
Akgöl Lake	*Carassius gibelio***	50	7.00	22.00	14.35 ± 0.609	7.10	228.40	72.73 ± 8.102
Gebekirse Lake	*Atherina boyeri***	59	5.80	9.50	6.76 ± 0.088	1.20	4.04	2.16 ± 0.084

*Endemic to the area, **Invasive

Table 3

LWR parameters and growth types of fish species

Species	n	a	b	SE_b	R^2	SE_r	t_{test}	GT
*Squalius fellowesi*i	188	0.012	2.980	0.038	0.980	0.086	$t_{cal} = 0.653 < t_{0.05,\ n = 187} = 1.66$	I
Perca fluviatilis	42	0.012	2.990	0.057	0.984	0.034	$t_{cal} = 0.169 < t_{0.05,\ n = 41} = 1.68$	I
*Oxynoemacheilus eliasi**	25	0.009	2.959	0.081	0.964	0.042	$t_{cal} = -0.497 > t_{0.05,\ n = 24} = 1.71$	I
*Cobitis fahireae**	5	0.004	3.176	0.067	0.986	0.058	$t_{cal} = 2.643 < t_{0.05,\ n = 4} = 2.13$	A (+)
Cyprinus carpio	10	0.013	3.121	0.204	0.966	0.043	$t_{cal} = -0.006 < t_{0.05,\ n = 9} = 1.83$	I
*Carassius gibelio***	50	0.024	2.914	0.062	0.978	0.061	$t_{cal} = 1.376 < t_{0.05,\ n = 49} = 1.68$	I
*Atherina boyeri***	59	0.008	2.884	0.195	0.792	0.060	$t_{cal} = 0.591 < t_{0.05,\ n = 58} = 1.68$	I

A (+): Positive allometric growth, I:Isometric growth, *Endemic to the area, **Invasive species for area

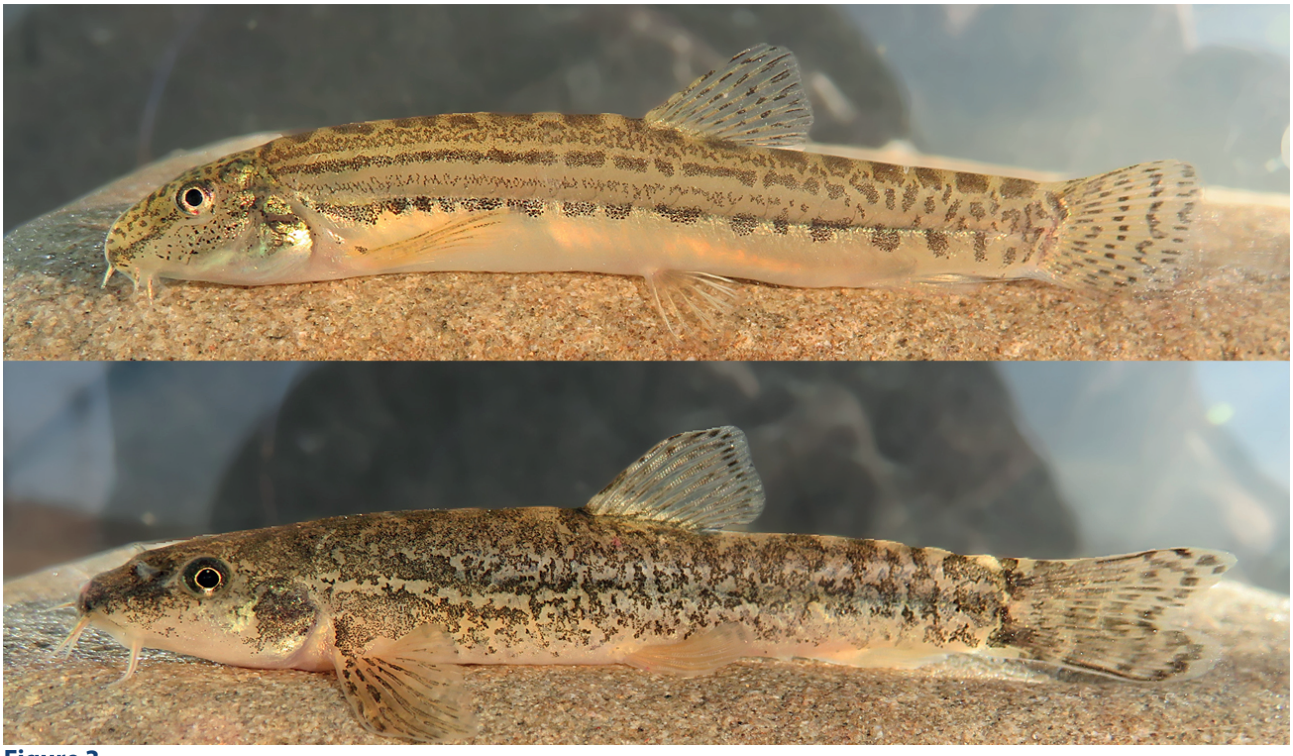

Figure 3

Living form of two endemics: *Cobitis fahireae*, 60 mm SL (upper) and *Oxynoemacheilus eliasi*, 68 mm SL (lower).

Table 4

Condition factors (K_F, K_R, and K_M) with standard errors of specimens

	N	Min	Max	Mean	SD	Var	SE	CI
Squalius fellowesii								
K_F	188	0.391	3.080	1.129	0.236	0.056	0.017	0.034
K_R	188	0.350	2.746	1.018	0.211	0.045	0.015	0.030
K_M	188	1.088	1.127	1.110	0.010	0.000	0.001	0.002
Oxynoemachelius eliasi								
K_F	25	0.703	1.018	0.863	0.081	0.006	0.016	0.034
K_R	25	0.346	1.568	1.114	0.042	0.044	0.042	0.085
K_M	25	0.585	1.021	0.796	0.131	0.017	0.026	0.054
Carassius gibelio								
K_F	50	0.975	2.456	1.964	0.239	0.057	0.034	0.068
K_R	50	0.506	1.295	1.009	0.122	0.015	0.017	0.035
K_M	50	1.869	2.062	1.948	0.054	0.003	0.008	0.015
Atherina boyeri								
K_F	59	0.529	1.026	0.714	0.098	0.010	0.013	0.026
K_R	59	0.663	1.513	1.064	0.206	0.043	0.027	0.054
K_M	59	0.390	0.820	0.684	0.095	0.009	0.012	0.025
Cobitis fahireae								
K_F	5	0.593	0.728	0.671	0.045	0.002	0.020	0.056
K_R	5	0.815	0.975	0.902	0.053	0.002	0.020	0.056
K_M	5	0.724	0.746	0.740	0.008	0.000	0.003	0.010
Cyprinus carpio								
K_F	10	1.625	2.173	1.901	0.174	0.030	0.055	0.125
K_R	10	0.882	1.157	1.004	0.091	0.008	0.029	0.065
K_M	10	1.842	1.956	1.894	0.036	0.001	0.011	0.026
Perca fluviatilis								
K_F	42	1.045	1.533	1.230	0.099	0.010	0.015	0.031
K_R	42	0.855	1.260	1.003	0.081	0.007	0.012	0.025
K_M	42	1.214	1.228	1.226	0.003	0.000	0.000	0.001

SD = Standard deviation, SE = Standard error, CL = Confidence intervals

maximum length was found for Akgöl Lake (L_{max} = 7.00 cm, W_{max} = 2.36 g).

The invasive species of the river – *C. gibelio* and *A. boyeri* – have established strong populations in the Küçük Menderes River Basin. *Carassius gibelio*`s maximum length and weight were found to be $L_{max}$ = 22.00 cm, $W_{max}$ = 228.40 g for Akgöl Lake; *A. boyeri*`s maximum length was found to be L_{max} = 9.50 cm, W_{max} = 4.04 g for Gebekirse Lake.

According to current study, the coefficient of determination results in all study area were highly correlated. The regression coefficient (*b*) varied between 2.844 - 3.176 in all the sampling locations, and the highest slope (*b*) constant was found for *C. fahireae* in the Akgöl Lake. The growth type of all specimens were isometric growth, except for *C. fahireae*, which showed positive allometric growth.

In the current study, the K_M, K_F and K_R ranged from 0.391 (*S. fellowesii*) to 3.080 (*S. fellowesii*); 0.304 (*O. eliasi*) to 0.882 (*C. carpio*), respectively (Table 4). If the LWRs regression coefficient (*b*), is not significantly different from 3, the Fulton`s Condition Factor can be used directly for comparing the values (Clark 1928).

4. Discussion

4.1. Current fish fauna

Recently, fish fauna of Küçük Menderes was studied in two comprehensive papers (İlhan et al. 2021; Saç et al. 2021) (Table 1). Saç et al. (2021) recognised 21 species from 50 sampling sites. Only 24 of these 50 sampling sites were located directly on the Küçük Menderes River and its tributaries, and 17 of these 21 species were determined in the river and its drainages. On the other hand, İlhan et al. (2021) recognised 13 fish species from nine sampling sites. The *Petroleuciscus* populations of the Küçük Menderes were identified as *Petroleuciscus smyrnaeus* by both studies. However, our morphologic features of our materials completely overlap with the diagnostic characters of *P. ninae* provided by Turan et al. (2018). Moreover, Küçük Menderes Petroleuciscus populations were recently confirmed to be *P. ninae* (Kaya et al. 2024). Besides, the *Cobitis* populations of the river were recognised as *Cobitis fahireae* in both studies. In addition to *Cobitis fahireae*, the existence of *C. afifeae* has also been reported in Küçük Menderes (Freyhof et al. 2018). The loach populations of the Küçük Menderes were identified as *Oxynoemacheilus germencicus* (Saç et al. 2021) or *Oxynoemacheilus theophilii* (İlhan et al. 2021); however, these populations have been recently described as a new species and named as *Oxynoemacheilus eliasi* (Yoğurtçuoğlu et al. 2022). Along with the above-mentioned issues, it is understood that there are 19 species still surviving in Küçük Menderes and its drainage area (Table 1).

4.2. LWRs analysis

As per Froese (2006), the regression slope (*b*) is typically expected to fall between 2.5 and 3.5. In the current study, the observed value of *b* aligns with the anticipated range. It is accepted that the proper value of *b* for fish is 3.0 (Hile 1936). Furthermore, the regressions were different, but lower than $b < 3$ in all species except both *C. carpio* (3.121), and *C. fahireae* (3.176). The highest *b* value was found for *C. fahireae* in Akgöl Lake. All the populations in the study showed isometric growth except the population of *C. fahireae* from Akgöl Lake, which shows positive allometric growth.

Although it is an endemic species of Western Anatolia water resources, there is still a lack of studies for local knowledge on the biological data of the *S. fellowesii*. In some of the limited studies, the LWRs of the species were evaluated: b = 2.760, from Işıklı Lake by Balık et al. (2002); as b = 2.802, from İkizcetepeler Reservoir by Koç et al. (2007); in 12 different sampling station between b = 2.9 - 3.4, from Muğla Province by Top et al. (2016), b = 2.607, from Küçükler Reservoir; and b = 2.597 from Buldan Reservoir by Güçlü and Küçük (2021), which is a very recent study from the Gediz River Basin. Most of the previous studies have been discussed from the reservoirs except for Işıklı Lake (Denizli province). It was expected that the reservoirs` fish population have smaller $b$ values than the natural ecological areas in terms of productivity differences of the reservoirs and natural water resources. In the Küçük Menderes River Basin`s water resources that have been investigated in the current study, Aktaş Stream has one of the healthy ecological habitats, and the anthropogenic pressure of on it is not big as the other resources. For these reasons (or just one of them) the b value of *S. fellowesii* might be greater than in the previous studies.

To date, the length and weight distribution were found to be SL_{min} = 4.49, SL_{max} = 6.08 from Akpınar Spring, and SL_{max} = 4.23 SL_{min} = 6.14 cm Gördes Creek (Gölmarmara, Manisa) for *C. fahireae* (Güçlü, Küçük 2015). LWRs of the *C. fahireae* species population from Biga Peninsula (from North-western Anatolia) was b = 3.315, for a = 0.0035 (İlhan et al. 2012). The reason for the differences of the b value of the *C. fahireae* might be related to the smaller sampling size of the current study (n = 5) or the anthropogenic pressure on the river drainage. The real situation of *C. fahireae* populations' health in the basin needs to be investigated with further studies.

In previous studies, there has been a lack of knowledge about the invasive species of the area. The limited studies were made in one of the closest basins, the Gediz River Basin. The LWRs of the invasive species found from the Gediz River`s different water resources changed respectively between b = 3.023 from Marmara Lake and b = 4.347 from Demirköprü Reservoir for *C. gibelio*; and b = 3.423 from Demirköprü Reservoir and b = 3.921 from Marmara Lake for *A. boyeri* (Güçlü, Küçük 2021). In another study, the b value was found to be b = 2.965 (for combined sexes) for *C. gibelio* species from Marmara Lake (Ilhan et al. 2020). In the current study, the b value of *C. gibelio* was found to be b = 2.914 from Akgöl Lake. According to previous studies, the b value of the current study is smaller. It is an accepted situation that the Gediz River Basin`s ecological habitat health is better than the Küçük Menderes River Basin`s ecological habitat health, so this might be the reason for the smallest b value of the species.

The variability in the b constant value is acknowledged, attributable to diverse factors. Standardizing the sampling procedure could potentially attribute differences in length-weight ratios (LWRs) values to habitat variations (Tesch 1971). Discrepancies in b values, as observed in other studies, may be influenced by factors including water quality and nutrient availability (Sparre et al. 1989). Moreover, differences in the number of samples, sampling period, and species sampling methods may contribute to the observed variations. The characteristics of the populations might be influenced by various parameters, such as stress, environmental changes, food resources, habitat health, and disease (Pauly 1993; Petrakis, Stergiou 1995). The geographical location, environmental factors, fish health, reproduction, sex, age, and stomach ingredients are the most effective features (Wootton 1998; Bagenal, Tesch 1978). Thus, the differences in the b constant may have been related to one or more of the factors mentioned above. According to personal observations, Küçük Menderes River drainage is under anthropogenic pressure and because of this pressure it cannot save its natural habitat structure.

In terms of growth type, isometric growth was determined for all specimens at the sampled localities except *C. fahireae*. In the current study, *S. fellowesii* showed isometric growth at Akgöl Lake, which is a natural water resource (see Table 2 and Table 3; b = 2.980; t_{cal} = 0.653 < $t_{0.05}$, n = 187 = 1.66). In a recent detailed study, the growth type of *S. fellowesii* were evaluated from 12 water resources from around Muğla Province, Western Anatolia (Top et al. 2016). In the related study, 10 populations of *S. fellowesii* showed isometric growth, while except for both Sarıöz and Gelibolu, streams showed positive allometric growth.

In the current study, Fulton's condition factor for all individuals ranged between 0.391 (*S. fellowesii*) to 3.080 (*S. fellowesii*); their relative condition factor ranged between 0.346 (*O. eliasi*) to 2.746 (*S. fellowesii*), respectively. Because one of the endemic species of the related study had the minimum relative condition factor values, discussing *O. eliasi*`s species CF might be useful. In previous studies, the condition factor of *O. eliasi* was studied only by Çiçek et al. (2022) as *O. germencicus*. As the Küçük Menderes loach populations have been described as *O. eliasi* (Yoğurtçuoğlu et al. 2022), we accepted and compared Çiçek et al. (2022)'s data as *O. eliasi*. In their study, the loaches from Kadın Stream (a drainage of Küçük Menderes River) K_F varied between 0.85-1.04

(K_{Fmean} = 0.91); their relative condition varied between 0.92-1.14 (K_{Fmean} = 1.00) in Çiçek et al. (2022). In the current study, Fulton`s Condition Factor was found to be K_{Fmin} = 0.703, and K_{Fmax} = 1.018 (K_{Fmean} = 0.863); their relative condition factor varied between K_{Fmin} = 0.346, and K_{Fmax} = 1.568 (K_{Fmean} = 1.114). In both studies, the K_F and K_R factors seem similar. The condition factor gives important clues about both abiotic and biotic factors playing a role in the physiological condition of the fish populations. In the study, CF of fish showed that the fish species have suitable environmental parameters in their natural habitats.

5. Conclusion

The specific goals of the study were to evaluate the LWRs, growth type, and condition data of the related fish species. Within the actual study, Küçük Menderes River drainage fish fauna was investigated in large frequency in the water resources of the western part of Anatolia. The present study considered basic information on the LWRs and CF for the established population of endemic, native, and invasive populations, which would be useful for fish researchers in the region. Although the simplicity of the methodology differed from basic methods by using limited data, the results of the study are useful for conservation studies, and fisheries management studies for the fish fauna of Küçük Menderes River basin. This may be the main reason for having a lower *b* value for many of the species. The LWRs and CF of 7 freshwater fish species were provided in this paper, of which two are endemic characteristics. As *O. eliasi*, *C. fahireae,* and *S. fellowesii* are endemic to the Western Türkiye (exceptionally, *S. fellowesii* was locally reported only on the islands of Lesbos and Samos outside of Türkiye), they have a special importance in Türkiye`s biodiversity with their status. These three species should be monitored in freshwater resources regularly, as the genus is under a threat because of different factors such as anthropogenic pressure and competition with invasive species. As a further study, conservation requirements should be investigated. The results of this research provide useful information for fisheries management, fish population dynamic studies, and comparisons for further studies.

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