Oceanological and Hydrobiological Studies

International Journal of Oceanography and Hydrobiology

Volume 54, No. 1 March 2025

pages (21-32)

sciendo

ISSN 1730-413X
eISSN 1897-3191

Describing biological parameters of several endemic *Salmo* species from the Caspian Sea and Persian Gulf basins

by

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DOI: **https://doi.org/10.26881/oahs-2025.1.03**
Category: **Original research papers**
Received: **July 30, 2024**
Accepted: **December 31, 2024**

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Abstract

Salmonids are a crucial component in aquatic ecosystems due to their trophic roles in nutrient cycling. They are also significant sources of food and salmonid fisheries make important contributions to local economies, while also being of cultural and recreational importance in many regions. To investigate the biological and population parameters of Salmonids in the Caspian Sea and Persian Gulf basins of Türkiye, we studied six endemic *Salmo* species. We sampled individuals from *Salmo araxensis*, *S. ardahanensis*, *S. baliki*, *S. fahrettini*, *S. munzuricus*, and *S. murathani* collected between 2006 and 2021 to analyse length–weight relationships and condition factors of these species. The total length of these *Salmo* specimens ranged from 3.60 cm to 27.40 cm, and their total weight varied from 38.00 g to 250.02 g. A high coefficient of determination ($r^2 \geq 0.97$) was observed in the species' populations. The study found that the growth parameters *a* and *b* varied across all populations between 0.0076–0.0118 and 3.003–3.444. The results of this study provide valuable data on endemic *Salmo* species in Türkiye's ecosystems and beneficial baseline information for future conservation efforts concerning these species.

Key words: biodiversity, economic fish, regression constants, slope value, trout

online at www.oandhs.ug.edu.pl

1. Introduction

The fish fauna of Türkiye is considered highly diverse (Bayçelebi, 2020; Bayçelebi et al., 2015; Freyhof et al., 2014, 2025; Kaya et al., 2016, 2020). The Anatolian region alone encompass three biodiversity hotspots, providing diverse freshwater habitats for a highly diverse native fish fauna, including salmonids (Freyhof et al., 2025). Salmonids are vital for ecological, economic, and cultural reasons. They are integral to commercial and recreational fisheries, significantly contributing to regional economies such as the Pacific Northwest and Scandinavia. Salmonids are a nutritious, omega-3-rich food source vital to seafood production and aquaculture (Zhang et al., 2023). They also serve as ecological indicators of water system health due to their sensitivity to habitat and water quality changes (Kroglund et al., 2008). Their unique life cycles, involving both freshwater and marine phases, enhance biodiversity and nutrient cycling, as they transport marine nutrients to freshwater ecosystems during spawning (Naiman et al., 2002). Salmonids are studied for their adaptability and migration, providing insights into fish biology and conservation (Liu et al., 2016), while also supporting sustainable aquaculture and holding cultural significance in traditions, fishing, and tourism. For these reasons, Salmonidae play a particularly important part in Türkiye in terms of fish biodiversity and socio-cultural values. In particular, native brown trout populations in Türkiye's water resources, with their considerable genetic diversity, represent an economic and ecological heritage that requires protection (Zencir Tanir & Fakioğlu, 2017).

Numerous studies investigated *Salmo trutta* Linnaeus, 1758, a species inhabiting Anatolia's freshwaters, focusing on systematics, reproduction, and growth (Karataş, 1999; Kuru, 1975; Slastanenko, 1995), making this species the most extensively researched fish species in Türkiye's waters (Alp et al., 2005; Arslan et al., 2007; Başusta et al., 2013; Gülle et al., 2007; Kaya, 2020; Kocabaş et al., 2012). Until the early 2010s, the diversity of salmonids in Anatolia was largely unknown. Subsequent systematic studies on the genus *Salmo* led to the description of sixteen new species (Turan & Aksu, 2021; Turan et al., 2010, 2011, 2012, 2014a, 2014b, 2017, 2021, 2022). While there is ample information on *Salmo trutta*, data on other members of the Salmonidae family are even more scarce. Moreover, data on their unique characteristics and population parameters remain limited, hindering the development of management strategies and conservation efforts for these species (Tarkan et al., 2008).

Seasonal variations in water regimes, along with domestic and industrial wastewater pollution and habitat destruction in both breeding and living areas, pose significant threats to the sustainability of brown trout populations (Zencir Tanir & Fakioğlu, 2017). These factors are likely to also affect the sustainability of other trout species. The impact of climate change further exacerbates these issues, leading to altered flow patterns and water temperatures in rivers and streams, which can disrupt the life cycles and migration patterns of salmonids (Ficke et al., 2007). Overfishing and illegal fishing practices contribute to the ongoing decline in populations and their respective sizes (Martinez et al., 2009; Okumuş et al., 2006), while the introduction of non-native species can lead to competition for resources and habitat, as well as the spread of diseases (Yoğurtçuoğlu et al., 2021). Additionally, the use of pesticides and chemicals in agriculture, which can seep into waterways, poses another risk to the health and survival of salmonids (Stanley & Preetha, 2016). Efforts to mitigate these threats include the implementation of stricter regulations on industrial discharges, improving wastewater treatment processes, restoring and conserving natural habitats, enforcing sustainable fishing practices, and conducting ongoing research and monitoring to better understand and manage salmonid populations (Young et al., 2018).

Fish biology demonstrates unlimited growth, resulting in continual changes in both length and weight (Longo et al., 2021). Fish exhibit continuous growth, with changes in length and weight influenced by water resource conditions (Longo et al., 2021). Understanding the length–weight relationship is vital for assessing fish stocks and life cycles in different habitats (Froese et al., 2011; Petrakis & Stergiou, 1995). The slope parameter (i.e. *b* values) in these relationships, which vary by region, sex, and habitat, are key for population monitoring (Froese & Pauly, 2023), with an optimal range of 2.5–3.5 for salmonids (Froese, 2006). The condition factor (CF) further aids in evaluating population health (Anene, 2005), while growth patterns, whether allometric or isometric, serve as indicators of population status (Froese, 2006; Tesch, 1971).

While the current literature reveals a significant amount of recent research on the biological and ecological aspects of fish stocks, many of Türkiye's endemic *salmonid* species still suffer from a lack of data. Although there are several studies on the distribution of the numerous species in the family

Salmonidae in Türkiye, there remains only anecdotal information on their biological parameters (Mazlum & Turan, 2018). In *FishBase*, for instance, there are still no detailed data available for the studied species in this research: *Salmo araxensis*, *S. ardahanensis, S. baliki, S. fahrettini, S. munzuricus,* and *S. murathani,* such as maximum length or weight (Froese & Pauly, 2023). This indicates that there remains a pressing need for biological data on members of the Salmonidae family, particularly regarding their length–weight relationships, growth types (GT), and CFs. The results of such research would not only aid in developing management strategies for this family but also contribute to a database for future studies. Therefore, it is hoped that the findings of this study will offer valuable data to support both conservation and management efforts. Hence, the main aim of this study is to identify lacking biological information for members of the Salmonidae family in Türkiye. For this, this study investigates six species of the *Salmo* genus and different water resources from both the Caspian Sea and the Persian Gulf basins in Türkiye.

2. Materials and methods

2.1. Study area

Sampling for Salmonidae was conducted in the basins of both the Caspian Sea and the Persian Gulf between 2006 and 2021 (Table 1 and Figure 1). For any further inquiries, the collection codes of the samples are presented in Appendix 1 (Recep Tayyip Erdogan University Zoology Collection of the Faculty of Fisheries, Rize).

2.2. Sampling method

The individuals were collected using the Samus 1000 model DC electrofishing equipment (manufactured in Poland) from river drainages. The research encompassed six species from the genus *Salmo*, with a total of 136 individuals investigated. To maintain the welfare of the fish, tricaine methane sulfonate (MS-222) anaesthesia procedures (concentration: 200 mg·l^{-1}) were employed prior to preservation in 5% formaldehyde.

This article does not contain any studies with human participants performed or experiments conducted on animals by any of the authors. Legal permission for collecting fish was provided by the Republic of Türkiye Ministry of Agriculture and Forestry (E-67852565-140.03.03-1800883). All care and use of experimental animals complied with international/national animal welfare laws, guidelines, and policies.

2.3. Laboratory part and statistical analysis

Fish samples were analysed at the Recep Tayyip Erdogan University, Faculty of Fisheries' Zoology Laboratory. The guide by Fricke et al., 2023 for nomenclature was followed. The total length (*L*) and total weight (*W*) of the fish were measured to the ± 0.1 cm and ± 0.01 g accuracy. The length–weight relationships of the fish samples were determined using a power function. For the analyses, the equation $W = aL^b$ was used, where W is the total weight (g), L the total length (cm), a the intercept, and b is the respective slope (Le Cren, 1951). Before the analyses, the coefficient of determination was calculated (r^2) to provide a quantitative measure of the explanatory power of

Table 1

Information of the studied locations.

Species	Locality	Latitude	Longitude	Year
Salmo araxensis	Kırkpınar Stream, Aras River, Caspian Sea Basin	40.854	43.019	2006
Salmo ardahanensis	Stream Toros, Kura River, Caspian Sea Basin	41.100	42.433	2014
Salmo baliki	Stream Sinek 1, A Tributary of Murat River, Persian Gulf Basin	39.731	43.482	2006
	Stream Sinek 2, A Tributary of Murat River, Persian Gulf Basin	39.758	43.464	2019
Salmo fahrettini	Stream Tekke, Euphrates River Persian Gulf Basin	39.819	41.152	2006
	Stream Ömertepe, Euphrates River Persian Gulf Basin	39.796	40.944	2007
Salmo munzuricus	Stream Mengel, Euphrates River, Persian Gulf Basin	39.314	41.163	2021
	Munzur Stream, Euphrates River, Persian Gulf Basin	39.346	39.132	2009
	A Tributary of Murat River, Persian Gulf Basin	39.475	43.267	2019
	Munzur Stream, Euphrates River, Persian Gulf Basin	39.347	39.134	2013
Salmo murathani	Keklik Stream, Aras River, Caspian Sea Basin	40.283	42.650	2006
	Arpaçay Stream, Aras River, Caspian Sea Basin	40.912	43.172	2017

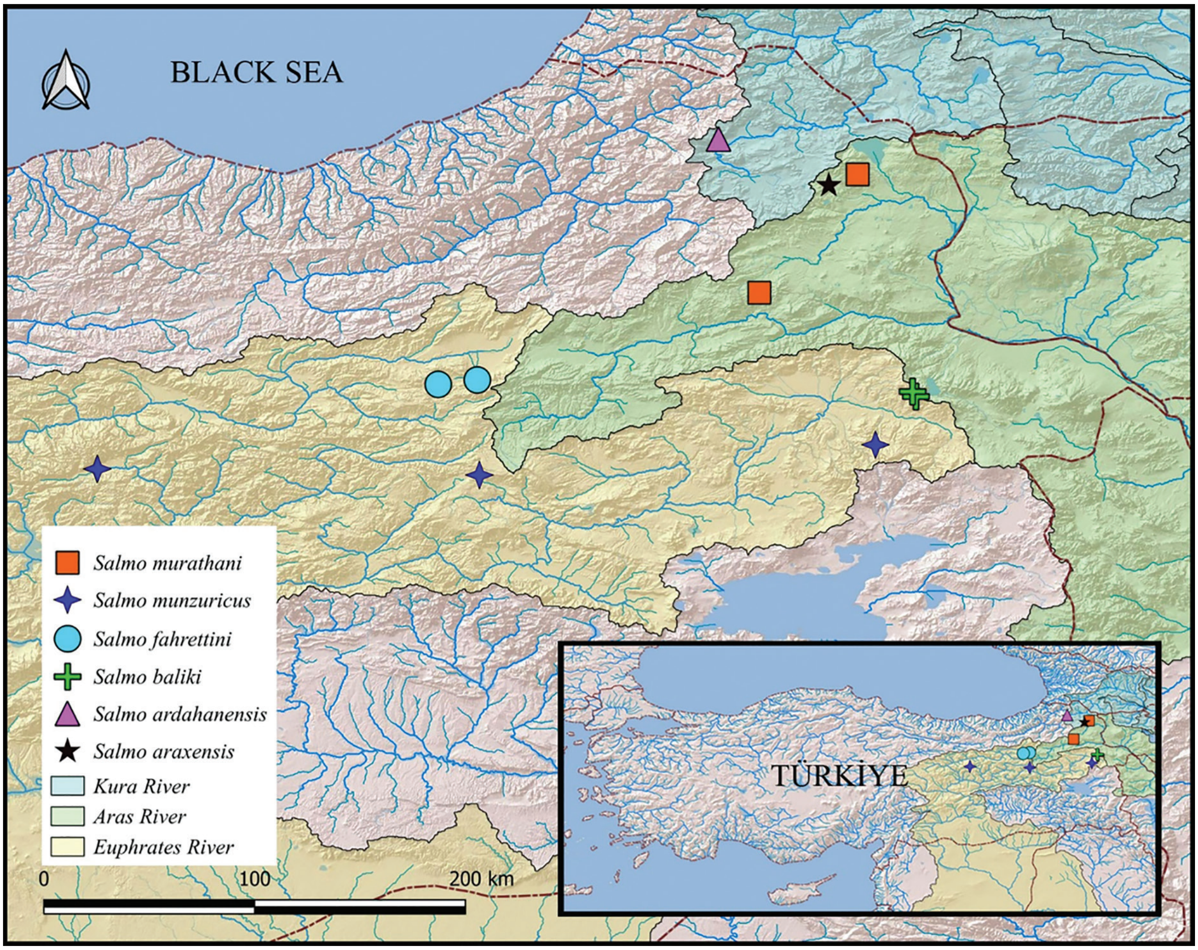

Figure 1

The sampling sites where the material examined for this study was collected.

regression models (Zar, 1999), and the correlation coefficient significance control test was applied. The *b* parameter's standard error was calculated. Then, we applied a *t*-test to identify discrepancies between the GT allometric using parameter *b* ($b = 3$, $p < 0.05$) by using the formula $t_c = b\text{-}3/se_{(b)}$ (Pajuelo & Lorenzo, 1998; Sokal & Rohlf, 1987). To analyse the condition of *salmonid* species, we computed the CF using the equation CF = 100 WL^{-3} (Froese, 2006). All analyses were performed using Microsoft Excel 2016.

3. Results

Sampling 136 specimens from *S. araxensis, S. ardahanensis, S. baliki, S. fahrettini, S. munzuricus*, and *S. murathani* (Figure 2), we found that the maximum length and weight recorded were 31.8 cm for *S. munzuricus* (from the Persian Gulf basin) and 451.60 g for *S. baliki* (also from the Persian Gulf basin), respectively. In contrast, the minimum length and weight were observed in *S. araxensis* from the Caspian Sea basin, with a length of 6.9 cm and a weight of 3.56 g (Table 2). The average length L_{mean} across all populations ranged from 14.73 cm in *S. araxensis* to 23.60 cm in *S. ardahanensis*. The maximum length and weight were found to be L_{max} = 31.8 cm (*S. munzuricus* from the Persian Gulf basin) and W_{max} = 451.60 g (*S. baliki* from the Persian Gulf basin), and the minimum length and weight were found to be L_{max} = 6.9 cm and W_{max} = 3.56 g (*S. araxensis* from the Caspian Sea basin) (see Table 2). The L_{mean} of all the populations varied between 14.73 cm (*S. araxensis*) and 23.60 cm (*S. ardahanensis*).

The r^2 values indicated a high correlation (between 0.97 and 0.99; for all populations as >0.97). The constant *a* ranged between 0.0033 and 0.0104 for the populations of all six species, while the constant *b* was found to be above 3.00 for all populations, revealing the highest *b* parameter as 3.4440 for *S. baliki* and the lowest value for *S. ardahanensis* (b = 3.0032). The mean CF ranged between 0.0998 (± 0.001) (for the species *S. araxensis* and *S. murathani*) and 1.010 (± 0.019)

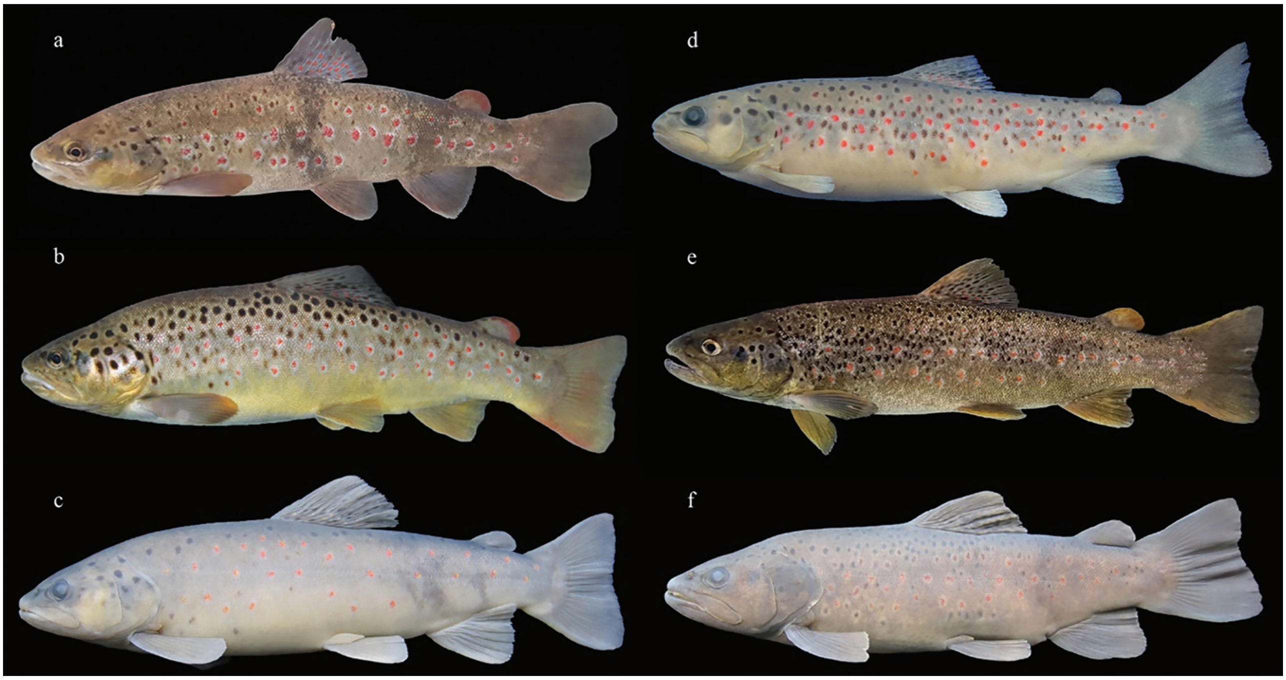

Figure 2

The salmonids examined in this study: (A) *Salmo baliki*, FFR 3242, holotype, 212 mm SL, male, Sinek Stream; (B) *S. murathani*, FFR 3228, paratype, 241 mm SL, female, Arpaçay Stream; (C) *S. araxensis*, FFR 3224, holotype, 259 mm SL, male, Kırkpınar Stream; (D) *S. fahrettini*, FFR03231, holotype, 232 mm SL, male, Stream Ömertepesuyu; (E) *S. munzuricus*, FFR 3226, 240 mm SL, male, stream Alakoçlu; (F) *S. ardahanensis*, FFR 3239, holotype, 222 mm SL, male, Toros Stream.

Table 2

Total length and total weight distribution with their min, max, and mean values and SD.

Species	Site	n	L_{min}	L_{max}	L_{mean}	SD	W_{min}	W_{max}	W_{mean}	SD
S. araxensis	Kırkpınar Stream	18	6.9	29.5	14.73	1.772	3.56	334.40	73.34	24.428
S. ardahanensis	Stream Toros	10	19.0	27.1	23.60	0.680	76.95	233.63	154.14	12.758
S. baliki	Overall	10	16.2	30.6	22.77	1.496	43.05	451.60	183.89	38.781
	Stream Sinek 1	3	20.7	29.6	24.76	1.95	119.94	316.63	214.44	46.46
	Stream Sinek 2	7	16.2	30.6	21.91	1.87	43.05	451.6	170.80	50.90
S. fahrettini	Overall	17	12.9	26.7	18.59	0.808	25.60	233.75	89.31	12.243
	Stream Tekke	2	20.7	21.8	21.25	0.38	123.89	141.88	132.88	6.36
	Stream Ömertepe	15	12.9	26.7	18.24	0.87	25.6	233.75	83.50	13.14
S. munzuricus	Overall	40	12.7	31.8	21.36	0.805	27.10	441.19	143.01	16.787
	Stream Mengel	4	12.7	23.6	17.62	2.26	27.1	193.96	97.53	35.05
	Munzur Stream	7	17.1	25.3	21.15	1.08	52.2	170.51	110.16	15.80
	Murat River Tributary	15	14	28.3	21.73	1.23	30.87	281.48	146.09	23.86
	Munzur Stream	14	15	31.8	22.14	1.58	37.64	441.19	169.13	36.79
S. murathani	Overall	41	7.3	27.7	16.02	0.836	4.43	296.09	69.69	11.037
	Keklik Stream	18	7.3	27.1	13.9	1.40	4.43	227.12	53.17	16.02
	Arpaçay Stream	23	11.3	27.7	11.3	0.86	16.69	296.09	82.62	14.60

Max, maximum; min, minimum; n, the number of the individual; SD, standard deviation.

Table 3

The parameters of the length–weight relationships of species with its statistical results, GT with *t*-test results and CF parameters with SD.

Species	Site	*n*	*a*	*b*	r^2	SE (b)	*t*-test	GT	CF_{min}-CF_{max}	CF_{mean} (SD)
S. araxensis	Kırkpınar Stream	18	0.0076	3.1510	0.99	0.001	$t_{cal} = 151 > t_{0.05,\, n = 18} = 2.10$	A (+)	0.838–1.132	0.998 (0.001)
S. ardahanensis	Stream Toros	10	0.0118	3.0032	0.98	0.023	$t_{cal} = 0.14 < t_{0.05,\, n = 10} = 2.28$	A (−)	0.941–1.072	1.003 (0.013)
S. baliki	Overall	10	0.0033	3.4440	0.98	0.015	$t_{cal} = 29.6 > t_{0.05,\, n = 10} = 2.28$	A (+)	0.882–1.077	0.998 (0.022)
	Stream Sinek 1	3	0.0197	2.8814	0.99	0.0265	$t_{cal} = -4.48 > t_{0.05,\, n = 3} = 3.18$	A (−)	0.88–1.06	0.98 (0.044)
	Stream Sinek 2	7	0.0024	3.5478	0.99	0.0171	$t_{cal} = 32.03 > t_{0.05,\, n = 7} = 2.36$	A (+)	0.89–1.07	1.00 (0.025)
S. fahrettini	Overall	17	0.0090	3.1440	0.98	0.007	$t_{cal} = 20.57 > t_{0.05,\, n = 17} = 2.11$	A (+)	0.896–1.097	0.999 (0.014)
	Stream Tekke	2	-	-	-	–	-	-	-	-
	Stream Ömertepe	15	0.0104	3.0684	0.99	0.0065	$t_{cal} = 10.52 > t_{0.05,\, n = 15} = 2.28$	A (+)	0.89–1.07	0.98 (0.013)
S. munzuricus	Overall	40	0.0088	3.1052	0.97	0.006	$t_{cal} = 17.53 > t_{0.05,\, n = 40} = 2.02$	A (+)	0.779–1.314	1.010 (0.019)
	Stream Mengel	4	0.0066	3.2673	0.99	0.0138	$t_{cal} = 19.37 > t_{0.05,\, n = 4} = 2.78$	A (+)	1.12–1.31	1.19 (0.036)
	Munzur Stream	7	0.0118	2.9768	0.93	0.0906	$t_{cal} = 0.26 > t_{0.05,\, n = 7} = 2.36$	I	0.80–1.09	0.91 (0.033)
	Murat River Tributary	15	0.0056	3.2481	0.98	0.0129	$t_{cal} = 213.33 > t_{0.05,\, n = 15} = 2.13$	A (+)	0.77–1.28	0.99 (0.026)
	Munzur Stream	14	0.0089	3.1072	0.99	0.0139	$t_{cal} = 7.72 > t_{0.05,\, n = 14} = 2.14$	A (+)	0.91–1.19	1.02 (0.028)
S. murathani	Overall	41	0.0080	3.1475	0.98	0.0007	$t_{cal} = 21.07 > t_{0.05,\, n = 41} = 2.02$	A (+)	0.875–1.131	0.998 (0.011)
	Keklik Stream	18	0.0091	3.0929	0.99	0.0015	$t_{cal} = 61.93 > t_{0.05,\, n = 18} = 2.10$	A (+)	087–1.13	0.99 (0.016)
	Arpaçay Stream	23	0.0055	3.2799	0.98	0.0046	$t_{cal} = 0.27 > t_{0.05,\, n = 23} = 2.07$	I	0.88–1.12	1.00 (0.015)

A (+): Positive allometric growth, A (−): Negative allometric growth, I: isometric growth.
CF, condition factor; GT, growth type; SD, standard deviation.

(for *S. munzuricus*) (see Table 3). The *t*-test found that while five of the *Salmo* populations showed a positive allometric growth pattern, *S. ardahanensis* expressed negative allometric growth patterns (Table 3).

4. Discussion

The discovery of 16 new *Salmo* species in Anatolia (Turan & Aksu, 2021; Turan et al., 2010, 2011, 2012, 2014a, 2014b, 2017, 2021, 2022) highlights the region's high degree of biodiversity. However, significant knowledge gaps remain, particularly regarding other members of the Salmonidae family. While studies on the distribution of these species exist, crucial data on their unique traits and population parameters are limited, hindering the development of effective management and conservation strategies (Tarkan et al., 2008). Though *S. trutta* has been relatively well studied, there is still a lack of information on other species, preventing a comprehensive understanding of emerging threats such as habitat degradation, climate change, and human impact.

Prior to this study, no data existed on length–weight relationships and CFs of the species of the genus *Salmo*. Our study fills this gap by providing information on length–weight relationships and CFs of *Salmo* species found in the Caspian and Persian Gulf basins, which may serve as the groundwork for further research on the fish populations. This study provides new information about the growth performance, length–weight relationships, and CFs of the endemic trout species inhabiting these two basins in Anatolia.

Despite employing traditional methods and working with a limited dataset, this study provides valuable biological data for six species from the Salmonidae family. This contribution is important as it is the very first study related to these species' biological parameters in both of these river basins. Despite previous research done in Türkiye, some results were obtained regarding the main trends in fish stock fluctuation; however, several endemic *salmonid* species do not have any biological database yet. Although distribution studies exist, detailed biological parameters are still scarce, such as maximum size and weight (Mazlum & Turan, 2018). Further species, such as *S. araxensis, S. ardahanensis, S. baliki, S. fahrettini, S. munzuricus*, and *S. murathani*, still lack critical data in resources like FishBase (Froese & Pauly, 2023). This gap in data hampers effective population monitoring and the formulation of management strategies, hence a need for more comprehensive studies to support the conservation effort.

The individuals collected in this study exhibited total lengths ranging from 6.9 cm to 31.8 cm and body weights varying from 3.56 g to 451.60 g. Moreover, *S. munzuricus* had the greatest length (L_{max} = 31.8 cm), while *S. fahrettini* recorded the shortest (L_{max} = 26.7 cm) among the species studied. The heaviest weight was noted in *S. baliki* (W_{max} = 451.60 g). The average length of the fish populations was calculated to range from L_{mean} = 14.73 ± 1.772 cm (*S. araxensis*) and 23.60 ± 0.680 cm (*S. ardahanensis*). A recent study by Mazlum and Turan (2018) provided a database with information on various *Salmo* species. According to their findings, new maximum length records were established for *S. abanticus* (45.1 cm), *S. chilo* (34.4 cm), and *S. caspius* (29.9 cm) (Fishbase, 2023). This current study contributes new maximum length data for six *Salmo* species. The collected individuals of *S. munzuricus* showed the highest maximum length of the studied species, with total lengths ranging from 12.7 cm to 31.8 cm and a L_{mean} of 21.36 ± 0.805 cm. *Salmo munzuricus* total weight ranged from 27.10 g to 441.19 g, with a W_{mean} of 143.01 ± 16.787 g. Conversely, *S. araxensis*, which had the smallest length sample, had a total length ranging from 6.9 cm to 29.5 cm, with L_{mean} = 14.73 ± 1.772 cm. This species' total weight ranged from 3.56 g to 334.40 g, with W_{mean} = 73.34 ± 24.428 g.

The detailed measurements of *Salmo* species in the study provide significant insights into the ecological roles and status of these salmonids in their respective habitats. The range in total lengths and weights observed among the species, such as the notable sizes of *S. munzuricus* and *S. baliki*, underscores the diversity within the genus, indicating varied ecological niches and roles in the food web (Musseau et al., 2015). Larger species like *S. munzuricus* likely occupy higher trophic levels and serve as key predators, exerting control over prey populations and thus influencing the overall biodiversity and balance in their ecosystems (Verep et al., 2016). The variation in average lengths and weights, as indicated by the differences between species like *S. araxensis* and *S. ardahanensis*, reflects the species-specific adaptations and ecological strategies (Sánchez-Hernández et al., 2012), being crucial for maintaining ecosystem resilience and functionality. Larger and heavier individuals, however, are typically more energetically efficient, contributing more significantly to the reproductive output and genetic diversity of populations (Garant et al., 2001). Furthermore, the establishment of new maximum length records for species such as *S. abanticus* and *S. chilo*, as reported by Mazlum and Turan (2018), highlights the dynamic nature of these populations and possibly indicates changes in habitat conditions or resource availability.

Hence, this report marks the first time that length–weight relationships for *S. araxensis, S. ardahanensis, S. baliki, S. fahrettini, S. munzuricus*, and *S. murathani* have been documented from the freshwaters of Türkiye. In this study, it was found that the *b* constant was greater than 3.00 for all the populations examined. Specifically, *S. baliki*, located in the Murat River of the Persian Gulf basin, exhibited the highest *b* value (3.444 ± 0.015) among all the *Salmo* species from both the Caspian Sea and Persian Gulf basins. Conversely, the lowest *b* value was recorded for *S. ardahanensis* in the Toros stream, part of the Kura River in the Caspian Sea basin, with a value of 3.0032 ± 0.023. Both biological and physical factors can significantly influence the length–weight relationships of fish populations. These factors include sex, seasonal variations, habitat characteristics, stomach fullness, and reproductive periods (Froese et al., 2011). Additionally, environmental factors such as maturity level, habitat health, stress, and availability of nutrients are crucial in determining the overall health of fish populations (Liang & Cai, 2020).

The findings from our study suggest that the *Salmo* populations are currently in a good state within their natural habitats, as indicated by their *b* constants being greater than 3 and their high CFs. However, it is important to recognise that *Salmo* species require high-quality water conditions for optimal health. Therefore, it is essential to protect and maintain the aquatic habitats of these *Salmo* species to preserve their population health and ensure their long-term survival. The CF of fish populations is a crucial indicator of their overall health and vitality, reflecting the physical condition of the fish and serving as a key metric for evaluating their welfare (Gücü et al., 2018). CF values are particularly informative in assessing the well-being of fish populations. In this study, the mean CF values of the populations were found to be high, ranging from 0.998 (± 0.001) to 1.010 (± 0.019). The highest mean CF was recorded in the *S. munzuricus* population from the Persian Gulf basin. On an individual level, the maximum CF was observed in *S. munzuricus*, while the minimum CF was noted at 0.838 in the *S. araxensis* population. Based on the results indicating high mean CF values in *salmonid* populations, it can be inferred that these populations are generally in good health and well-nourished. The higher CFs observed suggest that the salmonids are thriving in their environment, likely to benefit from adequate food availability, optimal habitat conditions, and effective management practices. This positive trend in CF is a promising indicator of the robust health and ecological well-being of the *salmonid* populations under study. Given the relationship between CF and reproductive activities, regular monitoring of the population's condition is critically important for the sustainability of fish stocks (Ferrer-Maza et al., 2016). Such continuous observation helps in understanding and managing the health and viability of these populations, ensuring their long-term conservation and management.

Our study has effectively filled the gap in data concerning the length-weight relationships and CFs of six endemic Salmonidae species in the studied region. We advocate for further research on the Salmonidae, focusing on developing strategies to protect their welfare. This should include exploring the effects of climate warming on fish behaviour, potentially employing biotelemetry methods to gain deeper insights. Additionally, future research could involve stable isotope analysis, using non-lethal techniques similar to those employed by Kurtul et al. (2023). Such methods would not only be less invasive but also provide valuable information about the ecological niches of Salmonidae and contribute to a more comprehensive understanding of their ecological roles and requirements, facilitating more effective conservation and management strategies.

Ethical statement

In this study, the number of sampled specimens of the genus *Salmo* was deliberately limited ($n < 45$ at each location) to adhere to ethical standards and ensure fish welfare.

Funding information

This research was supported by the Scientific and Technological Research Council of Türkiye (Project Number: TOVAG-106O259). The second author contributed to this manuscript while she was at Bournemouth University, and we would like to thank Bournemouth University for providing their facilities and TÜBİTAK BİDEB (2219 Program) that supported Irmak Kurtul with a 1-year scholarship during her post-doctoral research in the United Kingdom.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1

Basin	Coordinate	Date	Species	FFR	N
Kırkpınar Stream, Aras River, Caspian Sea Basin	40.854 43.0189	3.09.2006	*Salmo araxensis*[a]	3122	18
Stream Toros, Kura River, Caspian Sea Basin	41.100 42.433	21.09.2014	*Salmo ardahanensis*[a]	3164	10
Keklik Stream, Aras River, Caspian Sea Basin	40.283 42.650	6.09.2006	*Salmo murathani*[a]	3121	41
Arpaçay Stream, Aras River, Caspian Sea Basin	40.912 43.172	26.07.2017		3228	
Murat River, Persian Gulf Basin	39.731 43.482	5.09.2006	*Salmo baliki*[a]	3205	10
Stream Sinek, A Tributary of Murat River, Persian Gulf Basin	39.758 43.464	29.08.2019		3234	
Stream Tekke, Euphrates River Persian Gulf Basin	39.759 43.464	4.09.2006	*Salmo fahrettini*[a]	3232	17
Stream Ömertepe, Euphrates River Persian Gulf Basin	39.796 40.944	28.07.2007		3232	
Stream Mengel, Euphrates River Persian Gulf Basin	39.314 41.163	2.06.2021	*Salmo munzuricus*[a]	3241	40
Munzur Stream, Euphrates River, Persian Gulf Basin	39.346 39.132	19.10.2009		3147	
A Tributary of Murat River, Persian Gulf Basin	39.475 43.267	29.08.2019		3235	
Munzur Stream, Euphrates River, Persian Gulf Basin	9.347 39.134	26.10.2013		3162	

[a]Endemic to Türkiye.
FFR, Recep Tayyip Erdogan University Zoology Museum of the Faculty of Fisheries, Rize.

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