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Original Article

First data on big-scale sand smelt *Atherina boyeri* Risso, 1810 (Pisces: Atherinidae) from Kılıçkaya Dam Lake, Turkey

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Abstract
This research presents primary evidence regarding the occurrence of *Atherina boyeri* in Kılıçkaya Dam lake. A total of 345 specimens were obtained from local fishermen during May to June 2023. The sampled fish displayed a length range between 50.30 and 94.24 mm and weight between 0.76 and 4.30 g. The study established the length-weight relationship (LWR) based on total length (TL) as $W = 0.00002285\ L^{2.7018}$ for females, $W = 0.00003297\ L^{2.6033}$ for males and $W = 0.00002501\ L^{2.6746}$ for the pooled individuals. The exponential value *b* of TL-W ratio was determined as 2.6746, indicating negative allometric growth in the species. The average condition factor (CF) was computed as 0.641 ± 0.067. This investigation not only provides initial and valuable insights into the presence of *A. boyeri* in Kılıçkaya Dam lake but also enhances the understanding of the diversity of aquatic ecosystem. The findings of this study offer practical guidance to local fishery management authorities and decision-makers aiding in the implementation of suitable fishery management strategies to ensure the sustainability of fishery resources.

Keywords: big-scale sand smelt; first data; invasive species, Kılıçkaya Dam Lake; Türkiye

1 | INTRODUCTION

The *Atherina boyeri* Risso, 1810 is a teleost fish belonging to the class Atheriniformes and the family Atherinidae. This species is a type of fish that resides in seas, brackish waters, and freshwater habitats (Kottelat and Freyhof 2007). The diverse freshwater fish species in Turkey are under significant threat due to the introduction or translocation of invasive species, posing a particular risk to the sensitive species within aquatic ecosystems (Ekmekçi *et al.* 2013). Presently, the number of foreign or translocated species identified in Turkish inland waters is approximately 33, with notable examples among them being *Pseudorasbora parva*, *Carassius gibelio*, *A. boyeri*, and *Gambusia holbrooki* (Ekmekçi *et al.* 2013).

According to the data from the Turkish Statistical Institute (TÜİK) for the year 2022, the amount of big-scale sand smelt caught from inland waters in Turkey and introduced to the commercial market, totalling 6,976 tons, has elevated this species to the third position in the production of freshwater fish, following *Alburnus tarichi* and *Carassius gibelio* (Turkstat 2023). Beyond the economic benefits, it is imperative to carefully address the unregulated proliferation and subsequent population increase of this marine species within freshwater ecosystems (Kottelat and Freyhof 2007), given its associated economic and ecological ramifications. Aquatic ecosystems necessitate meticulous monitoring not only for their significance in fisheries but also for the preservation and sustainability of biological diversity (Turkstat 2023). As indicated by the IUCN Red List of Threatened Species, the conservation status of *A. boyeri* is Least Concern (LC), signifying its current exemption from substantial endan-

germent and it is not currently deemed to be under a notable threat of extinction (Freyhof and Kottelat 2008).

Atherina boyeri has penetrated Turkish inland waters via illicit pathways (Tarkan *et al.* 2014; Cilbiz and Uysal 2023). This species, characterised as pelagic, primarily relies on small crustaceans, worms, molluscs and juvenile fish as its primary food sources within lakes and freshwater ecosystems (Froese and Pauly 2022; Kale *et al.* 2022). The existence of *A. boyeri* has been formally documented in various freshwater environments across Turkey (Şimşek 2022; Benzer and Benzer 2023; Cilbiz and Uysal 2023).

Considering that the extended breeding period unique to *A. boyeri* is indicative of heightened reproductive effort, there is a potential risk that the species could pose to inland waters, thus requiring continuous monitoring (Patimar *et al.* 2009). Given the establishment of fishing cooperatives for export from Kılıçkaya Dam Lake and the absence of research on its presence there, the significance of this study lies in monitoring the species' existence, potentially aiding future decisions by fisheries authorities.

2 | METHODOLOGY

The study was carried out from May to June 2023 using *A. boyeri* individuals from Kılıçkaya Dam Lake (40°14′21″N 38°10′45″E), located within the provincial borders of Giresun and Sivas. Situated at an approximate distance of 160 km from the city centre, it holds its position. Inaugurated in 1989 with the principal aim of energy production, Kılıçkaya Dam was constructed along the course of the Kelkit stream. Spanning a designated surface area of 64.4 km^2, the reservoir stands elevated by 132 m from the riverbed, presenting a substantial altitude. Notably, the maximum water depth reaches 100 m. Erected between 1980 and 1989, Kılıçkaya Dam stands as a hydroelectric construction situated on the Kelkit River, geared towards energy generation. The reservoir area extends over 64.4 km², with 33 km² encompassing the administrative boundaries of Suşehri, Sivas and 31 km² within the jurisdiction of Şebinkarahisar, Giresun (Figure 1; Dirican *et al.* 2012).

Big-scale sand smelt samples were gathered on a monthly basis with the help of local fishermen at Kılıçkaya Dam Lake from May to June 2023. This scientific inquiry revolved around the examination of fish specimens, involving a meticulous recording of a range of foundational measurements. These measurements encompassed the total length (TL), fork length (FL) and standard length (SL) of the fish, each being meticulously quantified with a precision level of up to the nearest 0.1 mm. Furthermore, the total body weight (W) of each individual fish was meticulously assessed, ensuring a precision of 0.01 g. Following a macroscopic identification methodology, the sex of the individuals was determined.

FIGURE 1 Location of the study area, Kılıçkaya Dam Lake in Turkey.

The traditional approach to understand the growth characteristics of fish populations involves the utilisation of the length-weight relationships (LWRs) equation. This method establishes connections using the species' sex, length and weight data and typically, the relationship between TL and W for almost all fish species can be effectively explained through the equation known as the LWRs: $W = aTL^b$, where *W* is the weight of fish, L is the length (TL/SL/FL) of fish, and *a* and *b* are constants. The parameter *b* holds significant biological implications in the context of fisheries, as it signifies the pace of weight gain in comparison to length growth, or the rate of weight increase corresponding to a specific length augmentation. Growth is considered isometric when *b* equals 3, while growth is classified as allometric when *b* is less than 3 or greater than 3 (Ricker 1973). The constants *a* and *b* can be estimated through linear functions.

The Fulton condition factor (CF) was computed for all specimens utilised in the ongoing study, employing the equation by (Le Cren 1951): $CF = 10 \times W/TL^3$, where *CF* is the condition factor, *W* is the weight and *TL* is the length.

3 | RESULTS

During the entire duration of the study, it was ascertained that among the 345 big-scale sand smelt specimens, 50.72% (*n* = 175) were identified as male, whereas 49.28% (*n* = 170) were female. The sex distribution within the population was quantified as 1 : 1.03 for females and males respectively. This investigation presents the first observation of *A. boyeri* in the confines of Kılıçkaya Dam Lake in Giresun, Türkiye (Figure 2).

The fish exhibited a span of lengths, varying from 50.30 to 94.24 mm (TL), and encompassed weights ranging between 0.76 and 4.30 g. The calculated mean values for total length and weight, along with their corresponding standard error values, were determined as 67.04 ± 5.20 mm and 1.952 ± 0.442 g respectively (Table 1).

The LWRs were computed for female, male and pooled *A. boyeri* individuals from Kılıçkaya Dam Lake based on TL, SL and FL (Table 2, Figure 3). The LWR (TL) for female, male and pooled individuals was determined as $W = 0.00002285 \times TL^{2.7018}$, $W = 0.00003297 \times TL^{2.6033}$,

and $W = 0.00002501 \times TL^{2.6746}$ respectively. The exponential value b of the LWRs were calculated as 2.7018 (R^2 = 0.986), 2.6033 (R^2 = 0.991) and 2.6746 (R^2 = 0.988) for female, male and pooled individuals respectively (Table 2, Figure 3).

TABLE 1 Total length (TL), weight (W) and condition factor (CF) of *Atherina boyeri* in Kılıçkaya Dam Lake, Turkey.

Sex	Parameters (Mean ± SE, range)		
	TL	W	CF
Female	67.28 ± 5.86	2.025 ± 0.503	0.656 ± 0.070
(*n* = 170)	50.30 – 94.24	0.76 – 4.30	0.466 – 0.876
Male	66.80 ± 4.45	1.880 ± 0.360	0.626 ± 0.061
(*n* = 175)	54.20 – 83.10	0.98 – 3.47	0.466 – 0.823
Pooled	67.04 ± 5.20	1.952 ± 0.442	0.641 ± 0.067
(*n* = 345)	50.30 – 94.24	0.76 – 4.30	0.466 – 0.876

FIGURE 2 A specimen of *Atherina boyeri* from Kılıçkaya Dam Lake, Turkey.

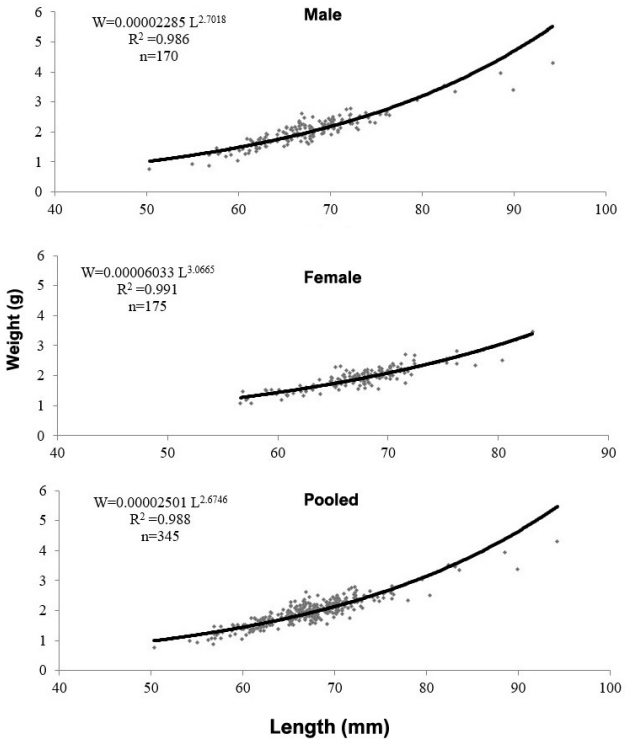

FIGURE 3 Length-weight relationships for female, male and pooled individuals of *Atherina boyeri* from Kılıçkaya Dam Lake, Turkey.

TABLE 2 Length-weight relationships of female (*n* = 170), male (*n* = 175) and pooled individuals (*n* = 345) of *Atherina boyeri* from Kılıçkaya Dam Lake, Turkey.

Group	Equations	R^2-values
Total length		
Female	$W = 0.00002285\ L^{2.7018}$	0.986
Male	$W = 0.00003297\ L^{2.6033}$	0.991
Pooled	$W = 0.00002501\ L^{2.6746}$	0.988
Standard length		
Female	$W = 0.00003456\ L^{2.6793}$	0.986
Male	$W = 0.00005274\ L^{2.5646}$	0.991
Pooled	$W = 0.00003875\ L^{2.6456}$	0.988
Fork length		
Female	$W = 0.00003883\ L^{2.6269}$	0.987
Male	$W = 0.00005691\ L^{2.5229}$	0.991
Pooled	$W = 0.00004284\ L^{2.5974}$	0.988

This suggests that all *A. boyeri* individuals displayed negative allometric growth. The formula derived from TL-based LWR calculations for individuals from Kılıçkaya Dam Lake was utilised, and the actual length-weight values along with error deviation values of 345 individuals are visually presented in Figure 4.

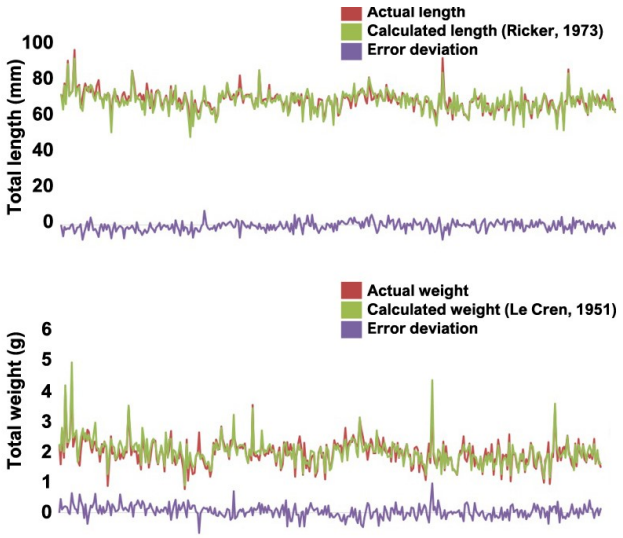

FIGURE 4 Actual and calculated total length and weight of *Atherina boyeri* from Kılıçkaya Dam Lake, Turkey.

4 | DISCUSSION

This study provides the first scientific data on the distribution and biology of *A. boyeri*, a species previously unrecorded in Kılıçkaya Dam Lake, aiming to offer essential insights for effective implementation of fisheries management strategies and ensuring the sustainability of aquatic resources in the region.

The slope (*b*) value of the TL-based LWR for *A. boyeri* individuals in Kılıçkaya Dam Lake was determined as 2.67. The obtained *b* value in this study was found to be lower than the values reported in the literature from other

studies (Table 3). In a study by Prato *et al.* (2020), it was reported that the *b* value ranged from 4.43 to 4.89 for *A. boyeri* individuals in the months of March-April when they did not lay eggs, and the *b* value was found to be 1.82 in June when they spawned. These results indicate that the occurrence of a low *b* value could be associated with the egg-laying periods. Additionally, when the *b* value is below 3, it is considered an indicator of insufficient suitable environmental conditions and inadequate overall growth for the fish (Kuriakose 2017). Therefore, in this context, it can be stated that the environmental conditions for *A. boyeri* individuals in Kılıçkaya Dam Lake are not favourable.

TABLE 3 Variation in length-weight relationships of *Atherina boyeri* across different habitats.

Habitat	*n*	*a*	*b*	r^2	GT	Source
Gomishan Wetland	2256	$5.3 \times 10^{-3*}$	3.06^{m}	-	A+	Patimar *et al.* (2009)
		$5.0 \times 10^{-3*}$	3.0630^{f}			
Hirfanlı Reservoir	323	-2.4023	3.2376	0,97	A+	Kirankaya *et al*. (2014)
Trasimeno Lake	3998	-2.326	3.139^{m}	0.956	A+	Lorenzoni *et al.* (2015)
		-2.366	3.168^{f}	0.968	A+	
Hirfanlı Dam Lake	674	3 × 10-6*	3.16	-	A+	Gençoğlu and Ekmekçi (2016)
Mellah Lagoon	1402	4.6×10^{-3}	3.179	0.944	A+	Boudinar *et al.* (2016)
Hirfanlı Dam Lake	1449	$1.3 \times 10^{-2*}$	2.77^{m}	0.971	A–	Benzer and Benzer (2017)
		$1.7 \times 10^{-2*}$	2.62^{f}	0.977	A–	
		$1.39 \times 10^{-2*}$	2.74	0.973	A–	
Bayramiç Reservoir	98	0.0044	3.2556	0.989	A+	Partal *et al.* (2019)
Süreyyabey Dam Lake	394	1.2×10^{-3}	2.67^{m}	0.983	A–	Benzer and Benzer (2019)
		6.7×10^{-3}	2.95^{f}	0.969	A–	
		6.4×10^{-3}	3.00	0.970	I	
Yamula Dam Lake	594	9.7×10^{-3}	2.8690	0.950	A–	Benzer (2020)
	516	10.7×10^{-2}	2.8169	0.934	A–	
Reyhanlı Dam Lake	103	0.004	3.091	0.613	A+	Şimşek (2022)
İznik Lake	635	$1.570 \times 10^{-5*}$	2.8266^{m}	0.942	A–	Benzer and Benzer (2023)
		$1.437 \times 10^{-5*}$	2.8602^{f}	0.947	A–	
		$1.328 \times 10^{-5*}$	2.8717	0.941	A–	
Kılıçkaya Dam Lake	170	$3.297 \times 10^{-5*}$	2.6033^{m}	0.991	A–	This study
	175	$2.285 \times 10^{-5*}$	2.7018^{f}	0.986	A–	
	345	$2.501 \times 10^{-5*}$	2.6746	0.988	A–	

The TL-based condition factor value of *A. boyeri* individuals in Kılıçkaya Dam Lake was determined as 0.64. It was found to be lower than the values reported by Çetinkaya *et al.* (2011) in İznik Lake (0.78 for males and 0.82 for females) and similarly, it was higher than the value reported by Kirankaya *et al.* (2014) in Hirfanlı Reservoir (0.62 for all individuals), and by Benzer and Benzer (2023) in İznik Lake (0.73 for males).

Intensive amateur and commercial fishing activities are conducted by the public in Kılıçkaya Dam Lake and among the targeted species of this substantial catch are stressed species such as *Cyprinus carpio*, *Leuciscus cephalus*, *Capoeta capoeta*, *Silurus glanis*, *Barbus plebejus* and *Clupeonella abrau muhlisi* (Uluozlu 2018). Various cooperatives in Giresun and Sıvas provinces export a significant portion of these species caught in diverse Anatolian habitats. In this context, *A. boyeri* could potentially become a new economic target species. However, being an invasive fish, *A. boyeri* might lead to alterations in the species composition of Kılıçkaya dam lake.

5 | CONCLUSIONS

This article encompasses the first documentation of *A. boyeri* in Kılıçkaya Dam Lake situated in Giresun, Turkey and constitutes a significant contribution to the scientific literature. Kılıçkaya Dam Lake emerges not only as a new distribution area for *A. boyeri* but also for various other aquatic species. In this context, the study outlines the spatial distribution of *A. boyeri* and provides valuable insights into the overall biodiversity of the habitat. To gain a deeper understanding of the ecosystem and biological diversity of Kılıçkaya Dam Lake, future studies should be conducted meticulously to investigate the population dynamics within the lake.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on a reasonable request from the author.

REFERENCES

Benzer S, Benzer R (2023) Growth parameters with traditional and artificial neural networks methods of big-scale sand smelt (*Atherina boyeri* Risso, 1810). Ege Journal of Fisheries and Aquatic Sciences 40(2): 96–102.

Çetinkaya S, Uysal R, Yegen V, Cesur M, Bostan H (2011) The growth characteristics of sand smelt (*Atherina boyeri*, Risso 1810) in lake İznik (Türkiye). Turkish Journal of Fisheries and Aquatic Sciences 11: 641–648.

Cilbiz M, Uysal R (2023) Stock assessment of *Atherina boye*ri Risso, 1810 using two different methodological approaches (length-based VPA and catch-only CMSY), in a freshwater ecosystem. Thalassas: An International Journal of Marine Sciences 39: 1–11.

Dirican S, Musul H, Çilek S (2012) Condition factors of some cyprinid fishes of Kilickaya Reservoir, Sivas, Turkey. Indian Journal of Animal Research 46(2): 172–175.

Ekmekçi FG, Kirankaya ŞG, Gençoğlu L, Yoğurtçuoğlu B (2013) Türkiye içsularindaki istilaci baliklarin güncel durumu ve istilanin etkilerinin değerlendirilmesi. İstanbul Uni Su Ürün Derg 28(1): 105–140 (in Turkey).

Freyhof J, Kottelat M (2008) The IUCN Red List of Threatened Species: e.T2352A174776839. 2008. www.iucnredlist.org (accessed on 10 November 2023).

Froese R, Pauly D (2022) FishBase. World Wide Web electronic publication. www.fishbase.org (accessed on 10 November 2023).

Kale S, Berber S, Acarlı D (2022) First record of *Atherina boyeri* Risso, 1810 in Atikhisar Reservoir (Canakkale, Turkey). Menba Kastamonu University Faculty of Fisheries Journal 8(1): 31–38.

Kirankaya ŞG, Ekmekci FG, Yalcin-Ozdilek Ş, Yoğurtcuoğlu B, Gencoğlu L (2014) Condition, length-weight and length-length relationships for five fish species from Hirfanlı Reservoir, Turkey. Journal of FisheriesSciences.com 8(3): 208–213.

Kottelat M, Freyhof J (2007) Handbook of European freshwater Fishes. Kottelat, Cornol & Freyhof, Berlin 14: 646 pp.

Kuriakose S (2017) Estimation of length weight relationship in fishes. Course manual: summer school on advanced methods for fish stock assessment and fisheries management. ICAR-Central Marine Fisheries Research Institute, India. pp. 215–220.

Le Cren ED (1951) The length-weight relationship and seasonal cycle in gonadal weight and condition in the perch, *Perca fluviatilus*. Journal of Animal Ecology 20: 201–219.

Patimar R, Yousefi M, Hosieni SM (2009) Age, growth and reproduction of the sand smelt *Atherina boyeri* Risso, 1810 in the Gomishan wetland–southeast Caspian Sea. Estuarine, Coastal and Shelf Science 81(4): 457–462.

Prato E, Grattagliano A, Lumare D, Lumare F, Ruscito A, Biandolino F (2020) Growth, mortality and yield of *Atherina boyeri* Risso, 1810 from Lesina Lagoon (Adriatic Sea, Italy). Acta Adriatica 61(2): 163–174.

Ricker W (1973) Linear regressions in fisheries research. Journal of the Fisheries Research Board of Canada 30(3): 409–434.

Şimşek E (2022) First record of economically important big-scale sand smelt (Risso, 1810, Pisces: Atherinidae) with some biological parameters from Reyhanli Dam Lake, Türkiye. Oceanological and Hydrobiological Studies 51(4): 337–343.

Tarkan AS, Güler Ekmekçi F, Vilizzi L, Copp GH (2014) Risk screening of non-native freshwater fishes at the frontier between Asia and Europe: first application in Turkey of the fish invasiveness screening kit. Journal of Applied Ichthyology 30: 392–398.

Turkstat (2023) Yearly Fisheries Statistics, Turkish Statistics Institute (TURKSTAT), Turkey.

Uluozlu OD (2018) Determination of trace metal levels in some fish species in Kılıçkaya Dam Lake from Sivas Turkey. Journal of Agricultural Faculty of Gazi-osmanpaşa University (JAFAG) 35(1): 19–27.

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