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-SHORT COMMUNICATION-

New Record of the Big-Scale Sand Smelt *Atherina boyeri* Risso, 1810 (Atherinidae) in the Seyhan Dam Reservoir (Seyhan River basin, Turkey)

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Abstract

Fifteen specimens of the big-scale sand smelt, *Atherina boyeri* were caught by a single trawl haul with a net mesh size of 3 mm on February 2017 from the Seyhan Dam Reservoir (South Anatolia, Adana/Turkey). In this study the big-scale sand smelt, *A. boyeri*, was recorded for the first time in the Seyhan Dam Reservoir. In addition, some morphometric and meristic measurements of *A. boyeri* were given and these values were compared to populations in two different lakes. Furthermore, the possible ecological effects of *A. boyeri* on Seyhan Dam Reservoir were briefly discussed.

Keywords:
Atherina boyeri, Seyhan River basin, Invasive Species, Non-native Species

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Introduction

Atherina boyeri is one of the 165 Atherinid species present in the seas around the world that is naturally found in the coastal areas of seas and oceans and river mouths. *A. boyeri* is euryhaline fish species. This fish species is often found in coastal lagoons, in brackish water with different salt levels, in entirely fresh water and highly salty water (pers. comm., Bardawil Lagoon, Israel

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that has 110 ppt maximum salt level (Gon & Ben Tuvia 1983; Henderson & Bamber, 1987; Kottelat & Freyhof, 2007). *A. boyeri* is prevalent in the Mediterranean and connected seas, and it is also found in northeastern Atlantic, from Azores to the south, to the southern and northwestern shores of Scotland and the southern parts of the North Sea. In addition, it is also present in Lake Aral and the Caspian Sea (Gon & Ben Tuvia, 1983; Quignard & Pras, 1986; Henderson & Bamber, 1987). *Atherina boyeri* is reported in Europe as a translocated species in landlocked lakes Lake Trasimeno Lake (Italy), Trichonis (Greece), Almyros Lake (Crete), and Kourna Lake (Crete) (Gon & Ben Tuvia, 1983; Freyhof & Kottelat, 2012; Barbieri et al., 2005). *A. boyeri* has become one of the most important economic species in lakes it is found especially in Greece (Boudinar et al., 2016) and Turkey.

First records of *A. boyeri* in the Turkish seas were given by Erazi (1942) and Akşiray (1987) and then the presence of the species in Turkish lakes were reported by Balık (1985), Meriç (1986a) and Meriç (1986b) in Küçükçekmece and Büyükçekmece Lakes. It was also reported in Lake Sapanca, Lake Köyceğiz and Güzelhisar River by Battalgil (1941), Kosswig & Battalgil (1943), Balık (1979), Geldiay & Balık (1988) and Altun (1999). After 2000s, the demands towards *A. boyeri* in international markets have increased. Besides, this specieswas reported another in landlocked lakes or rivers like İznik, Durusu, Eğirdir, Beyşehir, Ömerli Dam Reservoir, Hirfanlı Dam Reservoir and Mogan Lake (Özeren, 2009; Küçük et al., 2012; Saç et al., 2015).

In the latest studies, *A. boyeri* was also reported in Tigris drainage (Devegeçidi Dam Lake), Aslantaş Dam Reservoir on River Ceyhan, Obruk Dam Reservoir on Kızılırmak River, and in Kılıçkaya, Süreyya Bey and Babaoğlu Dam Reservoirs in the Yeşilırmak River (Kırankaya et al., 2016). While it is not known how *A. boyeri* was transported to landlocked reservoirs, it is thought that it was introduced by accident or intentionally (by commercial fishermen) to these lakes (Innal & Erk'akan, 2006; Küçük et al., 2009; Gençoğlu & Ekmekci, 2016). In the Seyhan River basin, *A. boyeri* is naturally present in the estuarine area, and in Akyatan and Tuzla lagoons (Saç et al., 2015), but it has not yet been reported in the upper parts of the river and in the Seyhan Dam Lake (Erk'akan & Özdemir, 2011; Ergüden & Göksu, 2012).

This study is reporting the presence of *A. boyeri* in Seyhan Dam Reservoir for the first time. Some meristic and morphometric measurement information for the population is given. Also, possible ecological effect *A. boyeri* might cause in the Seyhan Dam Reservoir was briefly discussed.

Materials and Methods

The study was performed in February 2017 in Seyhan Dam Reservoir on the Seyhan River (37° 05' 04.18'' N, 35° 16' 28.36'' E) (Figure 1). The temperature of the sampling area was measured as 16.75 °C, salt level as 0.34, pH as 8.54, dissolved oxygen as 9.17 mg/L and conductivity as 0691 mS/cm (measurements were taken using a YSI probe). Sampling was performed using a single trawl haul with a net mesh size of 3 mm. 15 specimens caught were brought to the lab in Çukurova University Aquaculture Department Faculty of Fisheries and here they were confirmed as *A. boyeri* by following Palmer et al. (1979), Akşiray (1987), Kottelat & Freyhof (2007) and Geldiay & Balık (2002).

Morphometric measurements given in Table 1 were taken from the individuals caught. The overall appearance of the species was given in Figure 2. Measurements were taken using a digital caliper with a sensitivity of 0.1mm according to Palmer (1979) and Altun (1999). In addition, the number of scales on the lateral line, the number of rays on the dorsal, ventral, pelvic and anal fins and weight were measured. Also, to determine the number of vertebrae, radiography image was taken according to Lowe & Lewbart (1997) using Siemens Heliodent 56 KVP X-ray with equipped Agfa CR 30-X printer.

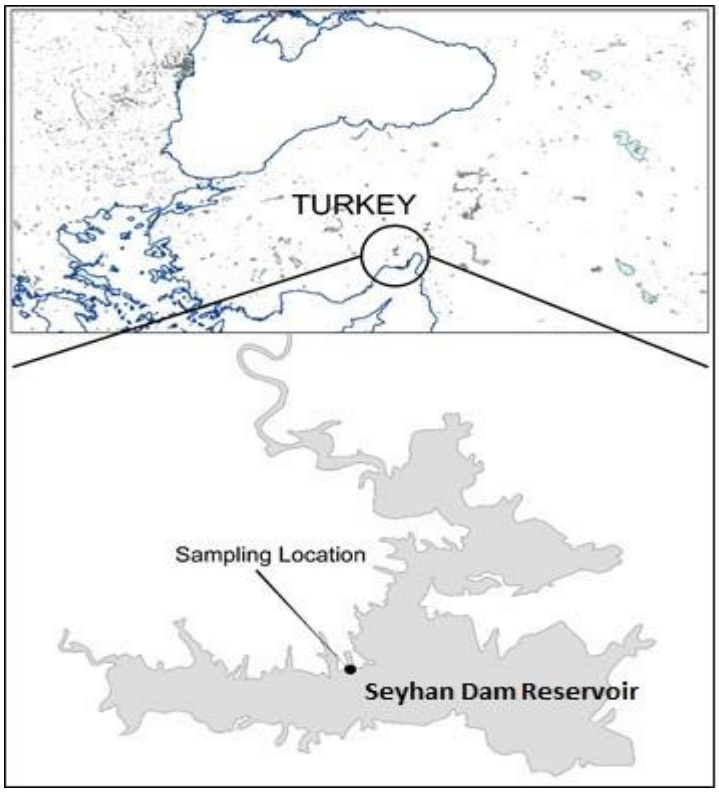

Figure 1. The overall appearance of Seyhan Dam Reservoir and the sampling area

Figure 2. The overall appearance of *A. boyeri* caught in Seyhan Dam Reservoir

Results

As seen in measurements given for 15 individuals on Table 1. Some metrics and meristic characters measured and counted in the Seyhan Dam Reservoir population were compared to the values taken from other populations (Devegeçidi Dam Lake and İznik Lake), (Table 1).

Table 1. Morphometric and meristic measurements of *A. boyeri* caught in Seyhan Dam Reservoir

Measurements*	**Present Study**		**Ünlü et al. (2017)**		**Altun (1999)**	
	(Seyhan Dam Reservoir)		**(Devegeçidi Dam Lake)**		**(İznik Lake)**	
Metric	Mean±SD (n=15)	Range (n=15)	Mean±SD (n=15)	Range (n=15)	Mean±SD (n>15)	Range (n>15)
TL	83.8 ±9.50	72.1 - 100.1	47.0 ± 4.2	43.3–59.9	9.38	8.3-l0.4
FL	77.7 ±8.58	66.0 - 92	44.1 ± 3.6	40.3–55.1	-	-
SL	72.1 ±7.70	61.0 - 85	40.7 ± 3.4	37.7–50.9	-	-
W	3.6 ±1.11	2.1 - 5.90	2.9 ± 3.2	0.7–8	-	-
HL	12.9 ±1.64	10.9 - 160	9.6 ± 1.1	8.4–12.9	-	-
HD	5.7 ±0.87	4.1 - 7.10	6.3 ± 0.5	5.4–7.5	-	-
ED	3.4 ±0.58	2.8 - 4.50	3.5 ± 0.5	3.0–4.9	-	-
IO	2.6 ±0.43	2.1 - 3.10	3.2 ± 0.2	2.6–3.4	-	-
POL	3.9±0.82	2.1 - 5.50	3.5 ± 0.4	3.0–4.6	-	-
PRL	2.4 ±0.42	1.9 - 3.10	2.7 ± 0.4	2.2–3.3	-	-
LD1	24.2±8.14	4.1 - 33.10	18.5 ± 1.6	16.4–23.3	-	-
LD2	44.3 ±5.55	36.1 - 53.8	26.9 ± 1.9	24.8–32.3	-	-
D1-D2	8.7 ±1.98	5.1- 11.7	5.7 ± 0.7	4.8–7.3	-	-
CPL	24.5 ±3.02	20.1 - 31.1	14.9 ± 1.7	11.3–17.7	-	-
CPD	3.0±2.09	1.1 - 8.1	2.6 ± 0.2	2.2–2.9	-	-
P-V	8.3 ±1.99	4.5 - 11.1	6.6 ± 0.7	5.8–8.0	-	-
V-A	16.2 ±1.95	13.9 - 20.1	8.3 ± 1.1	6.2–10.8	-	-
TL/FL	1.0 ±0.03	0.9 - 1.1	1.1 ± 0.02	1.0–1.1	-	-
TL/SL	1.1 ±0.04	1.0 - 1.2	1.2 ± 0.03	1.1–1.2	-	-
FL/SL	1.0 ±0.02	1.0 - 1.1	1.1 ± 0.02	1.1–1.1	-	-
SL/HL	5.5 ±0.31	5.0 - 6.1	4.3 ± 0.38	3.8–5.0	-	-
SL/HD	12.6±0.97	11.4 - 15.3	6.5 ± 0.63	5.5–8.1	-	-
HL/HD	2.2±0.18	2.1 - 2.7	1.5 ± 0.19	1.3–2.1	-	-
HL/ED	3.8±0.38	2.9 - 4.3	2.8 ± 0.26	2.3–3.3	-	-
LD1/LD2	0.5±0.19	0.1 - 0.6	0.7 ± 0.02	0.7–0.7	-	-
POL/PRL	1.6 ±0.41	0.6 - 2.1	1.3 ± 0.20	1.1–1.7	-	-
CPL/CPD	11.3±6.67	2.4 - 28.2	5.8 ± 0.32	5.1–6.6	-	-
P-V/V-A	0.4 ±0.15	0.1 - 0.8	0.8 ± 0.11	0.7–1.1	-	-
HL/SL (%)	22.6 ± 0.18	21.0 – 27.1	23.6 ± 2.02	20.0–26.2	23.0 ± 0.71	21.7–24.5
ED/HL (%)	26.0 ± 0.03	23.0 – 35.0	36.5 ± 3.34	30.0–42.7	30.9 ± 1.1	28.3–33.3
LD1/SL (%)	34.0 ± 0.12	5.0 – 42.0	45.4 ± 2.31	40.9–50.7	44.3 ± 1.02	42.1–46.3
LD2/SL (%)	61.0 ± 0.04	56.0 – 75.0	66.2 ± 2.02	62.0–69.8	66.7 ± 0.73	65.0–68.3

D1-D2/SL (%)	12.0 ± 0.02	8.0 – 16.0	14.1 ± 1.34	11.8–16.2	15.0 ± 0.86	13.3–17.2
Meristic	(Seyhan Dam Reservoir) Range		(Devegeçidi Dam Lake) Range		(İznik Lake) Range	
SQ	44 - 48		46 - 49		45 - 4 9	
Vert	42 - 45		43 - 46		42 - 47	
GR	25 - 28		24 - 26		27 - 32	
D1	VI - VII		VI - VII		VI -X	
D2	I 10 - 12		I 10 - 12		I 10-13	
A	I 12 - 14		I 12 - 14		I 12-14	
P	13 - 16		13 - 16		13 - 16	

*Total length (TL), fork length (FL), standard length (SL), total weight (W), head length (HL), head depth (HD), eye diameter (ED), interorbital distance (IO), postorbital length (POL), pre-orbital length (PRL), pre-dorsal length from first dorsal fin (LD1), pre-dorsal length from second dorsal fin (LD2), distance between two dorsal fins (D1-D2) caudal peduncle length (CPL), caudal peduncle depth (CPD), distance between pectoral and ventral fins (P-V), distance between ventral and anal fins (V-A),SQ: Squame lateral, Vert: Number of vertebrae, GR: Gill rakers, D1: First dorsal fin rays, D2: Second dorsal fin rays, A: Anal fin, P: Pelvic fin

Minimum total weight was measured as 2.1 gr, maximum total weight as 5.9 gr, and average total weight was calculated as 3.6 gr (Table 1). Head length varied between 20.1 mm - 31.1 mm, head depth was in the range of 4.1 mm -7.1 mm (Table 1). The number of rays was 6-7 in the first dorsal fin, 10-12 in the second dorsal fin, 12 - 14 in the anal fin, 13 - 16 in the pectoral fin and 7 - 8 in the pelvic fin (Table 1). The number of barbs on the gills were determined as 25 - 28 (Table 1). The number of scales on the squame lateral was determined as 44 - 48 (Table 1). In the radiographical image taken, the number of vertebrae was counted as 42 -45 (Figure 3).

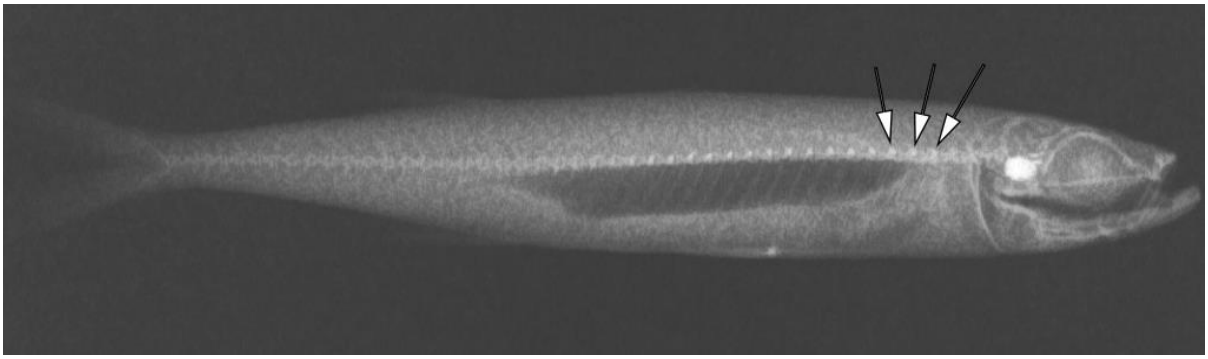

Figure 3. The radiographic appearance of *Atherina boyeri* caught in Seyhan Dam Reservoir (TL= 8.3 cm, W=3.50 g)

Discussion

In this study, meristic counts of *A. boyeri* were determined to be similar to the population in Devegeçidi Dam Reservoir (Ünlü et al., 2016) and Iznik Lake (Altun, 1999). Concerning gill rakes, the population in the Seyhan Reservoir was determined to be similar to the Devegeçidi population. However, it was found that the number of gill rakes in the Lake Iznik population is higher than both of the other dam lakes (Table 1).

Ratios regarding some metrics of *A. boyeri* from different populations compared to the measurements in this study. The values found in this study were determined to be different from those in Altun (1999) and Ünlü et al. (2016). It is known that these differences are caused by the differences of environmental conditions in the areas the populations are found, and errors in the measurements. For this reason, it was considered that our findings and the findings of other researchers are different.

Atherina boyeri, a native-translocated fish for Turkey, is one of the target fish species in landlocked inland waters. According to TUIK data, 3680-6677 tons of *A. boyeri* was caught between 2006-2015 (TUIK 2016). Being an economical species, easily adapting to inland waters, fast growth and school forming behavior suggests that this species is deliberately introduced to lakes and rivers by those who have a commercial interest in fish (Gençoğlu, 2010). Previous studies in Seyhan Dam Reservoir didn't encounter *A. boyeri* (Balık, 1985; Bostancı, 2006; Erk'akan & Ozdemir, 2011; Ergüden & Göksu, 2012). *A. boyeri* found in this study is thought to be introduced by those with a commercial interest in fish, like the other lakes in Turkey. After determining that the species was *A. boyeri*, dives performed in the lake encountered *A. boyeri* schools of various sizes, suggesting that *A. boyeri* has adapted to the lake.

After its appearance in the inland waters in Turkey in the 1970s, *A. boyeri* has spread rapidly, became a dominant species in the habitats it is found and started affecting negatively, quickly becoming an invasive species. For example, in the Hirfanlı Dam Reservoir, in the 1970s, the dominant and most caught species was the local/endemic *Alburnus escherichii*, but in stock determination studies in 2005, the dominant species is found to be *A. boyeri*, previously not known to be present in the lake (DSI 2005). Until then, *A. boyeri* maintains its status as the most caught species, while latest studies report that no *Alburnus escherichii* is found (Innal, & Erk'akan, 2006; Ekmekçi et al., 2013; Gençoğlu & Ekmekci, 2016; Kırankaya et al., 2016).

Obviously, if *A. boyeri* becomes the dominant species in the Seyhan Dam Reservoir, it will affect the native species it shares same niche with, *Alburnus orontis*, and our local/endemic species *A. adanensis*. Because both species share the pelagic zone close to the surface with *A. boyeri* and feed on zooplankton. On the other hand, *A. boyeri* is an opportunistic carnivore, feeding on zooplankton and depending on the abundance of food, benthic invertebrates (mostly Crustacea), insect nymphs and adult fish and fish eggs (Bartulovic et al., 2004). In the Seyhan Dam Reservoir, if *A. boyeri* feeds in the benthic zone, other fish present in the lake and feeding from the benthic zone might be effected negatively.

In conclusion, monitoring the *A. boyer*i population in the Seyhan Dam Reservoir and researching its biological and ecological characteristics would be advisable for the future of the lake ecosystem.

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