



Additional record of *Anatolichthys marassantensis* from Simenlik-Akgöl Lagoon in lower Yeşilırmak Drainage (Türkiye)

Melek ÖZPİÇAK, Semra SAYGIN, Savaş YILMAZ, Nazmi POLAT

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Ondokuz Mayıs University, Sciences and Arts Faculty, Biology Department, Samsun, Türkiye

ORCID IDs of the author(s):

M.Ö. 0000-0003-3506-4242
S.S. 0000-0002-3249-5074
S.Y. 0000-0003-2859-4886
N.P. 0000-0001-9785-9927

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Correspondence:

Melek ÖZPİÇAK

E-mail: melek.zengin@omu.edu.tr



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ABSTRACT

Anatolichthys marassantensis widely distributed in Kızılırmak drainage, and few records also available from Yeşilırmak drainage. However, the existing literature has not provided a morphological comparison between Kızılırmak and Yeşilırmak populations in a systematic approach. The present study examines, for the first time, the morphology/morphometry of *A. marassantensis* from both of the drainages based on additional material from Simenlik-Akgöl Lagoon Lake in Yeşilırmak drainage and published data (type materials) from Kızılırmak River. A total of 40 specimens from Simenlik-Akgöl Lagoon were compared for morphometric and morphological characters with the type measurements. According to the results of this study, morphological characters largely overlapped between selected populations of Yeşilırmak and Kızılırmak Rivers. The results obtained from this study clearly demonstrate the presence of *A. marassantensis* in a new location in the Yeşilırmak drainage with consistent morphological data.

Keywords: *Anatolichthys marassantensis*, Simenlik-Akgöl Lagoon Lake, Aphaniidae, New record

Introduction

Freshwater fish diversity and endemism are high in important biodiversity hotspots such as the Caucasus, Iran-Anatolia, and the Mediterranean basin (Perea et al., 2010). Türkiye has a rich diversity and endemism in terms of freshwater fish, because of having both European- and Asian origin species (Tarkan et al., 2015). Killifishes of the family Aphaniidae is one of the largest groups of fishes in the Western Palaearctic and represented by the highest number of species in Central Anatolia (Hrbek & Meyer, 2003; Freyhof & Yoğurtcuoğlu, 2020). The killifishes in Anatolia are also unique such that represented by four genera, two of which are endemic, i.e. the monospecific *Kosswigichthys* and the most species-rich genus *Anatolichthys*. While many of the species of *Anatolichthys* are restricted to a single lake basin with a definite distribution, others are widely distributed over a wide range in larger river drainages with poorer data on their ranges. *Anatolichthys marassantensis* is one of such wider species distributed in Kızılırmak and Yeşilırmak drainages.

Freyhof & Yoğurtcuoğlu (2020) reported that 21 species of killifishes are distributed in Anatolia and many of which are threatened and poorly explored. The populations from Kızılırmak and Sultan marshes were collectively treated as *Aphanius danfordii* until the description of populations from Kızılırmak River drainage as *A. marassantensis* by Pfeleiderer et al. (2014). Since that time, *Anatolichthys marassantensis* was demonstrated particularly from Hirfanlı Reservoir and Kızılırmak River Delta (Yoğurtcuoğlu & Ekmekçi, 2013). Gül and Atasagun (2022) have reported from Delice River (Kızılırmak). Hrbek et al. (2002) reported population from lower Yeşilırmak River. Yoğurtcuoğlu & Ekmekçi (2017) have reported new records of the *Aphanius marassantensis* from Central Yeşilırmak, and Benzer (2018) have reported from Süreyyabey Dam Lake from Yeşilırmak. After a recent taxonomic revision the species of *A. anatoliae* group was re-transferred to *Anatolichthys* (Freyhof & Yoğurtcuoğlu, 2020).

Although these publications has tried to reveal the exact distribution of *Anatolichthys marassantensis*, none of them provided a morphological comparison between Kızılırmak and

Yeşilırmak River populations. Therefore, the aim of this study is to test if populations from Kızılırmak and Yeşilırmak River differed. Moreover, improving the knowledge of the distribution of *A. marassantensis* is crucial in order to adequately inform conservation planning and thus guarantee its long-term survival. In this study, we have proved the occurrence of *A. marassantensis* in the Simenlik-Akgöl Lagoon Lake from Samsun. Also, *A. marassantensis* is a new record for this area and fish fauna of Samsun.

Material and Methods

Sampling Site

Simenlik-Akgöl Lagoon Lake is located in 25 km to the center of Terme in the province of Samsun. This area is located within the borders of the Yeşilırmak Delta. Simenlik Lake, with an area of 80 hectares and a delta depth of 0.5-3 m, connects to the Black Sea by a channel from the northwest; it creates a lagoon complex by linking to Akgöl, which has an area of 50 hectares and an average depth of 3 m, via a channel from the southeast (Anonymous, 1990). Simenlik Lake and its surrounding lakes and wetlands (16043.0 he) were first declared as a conservation area in 1975 (Anonymous, 2013; Karaer et al., 2017). After this decision, Simenlik-Akgöl Lagoon Lake and other aquatic ecosystems around it were evaluated together and taken under protection. The fact that Simenlik Lake is connected to the Black Sea as a result of rising water levels during rainy seasons affects the lake's salinity. As a result, numerous freshwater animals are impacted by this situation (Karaer et al., 2017). *Anatolichthys marassantensis* samples were collected from the following coordinates, 41°16' 41.952" N - 36°56'29.868" E. *Mugil cephalus*, *Mugil saliens*, *Esox lucius*, *Carassius gibelio*, *Tinca tinca* and *Abramis brama* were recorded from Simenlik by Uğurlu (Helli) & Polat, 2003. In addition, Uğurlu et al. (2008) and Polat & Uğurlu (2011) were added *Syngnathus abaster*, *Platichthys flesus*, *Atherina boyeri*, *Gasterosteus aculeatus*, *Neogobius melanostomus* and *Proterorhinus marmoratus* to fish fauna of Simenlik-Akgöl Lagoon Lake. We followed Eschmeyer's Catalog of Fishes (Fricke et al., 2022) for the most recent and valid taxonomy.

Table 1. Morphometric data of *Anatolichthys marassantensis* from Terme Stream (Black Sea-Türkiye)

| Morphological variables | Holotype | This study | | Pfleiderer et al. (2014) | |
|---|----------|-----------------------------|-----------------------------|--------------------------|--------------------------|
| | | Female N=15 | Male N=24 | Female N=15 | Male N=14 |
| Standard length (mm) | 32.61 | 31.27-37.31 | 25.70-30.30 | 31.3-42.6 | 28.3-37.5 |
| In percent of standard length | | | | | |
| Head length | 35.87 | 26.59-38.32 (29.80 ±1.8) | 27.41-40.73 (33.89 ±0.6) | 26.5-30.8 (29.1 ±1.1) | 27.9-32.2 (30.5 ±1.2) |
| Predorsal length | 70.77 | 64.95-76.06 (69.03 ±2.8) | 62.18-75.40 (66.68 ±0.7) | 61.1-65.3 (63.4 ±1.4) | 57.0-63.0 (60.5 ±1.8) |
| Preanal length | 72.79 | 68.91-79.36 (74.48 ±1.5) | 56.40-78.22 (69.94 ±1.3) | 68.4-74.6 (70.8 ±1.7) | 63.6-69.9 (66.3 ±2.2) |
| Prepelvic length | 56.67 | 54.98-63.39 (58.04 ±2.3) | 50.48-70.17 (58.27 ±0.9) | 52.8-59.2 (55.9 ±2.1) | 51.1-55.6 (53.5 ±1.3) |
| Height of dorsal fin | 16.56 | 12.82-24.18 (18.58 ±3.1) | 18.61-29.33 (24.21 ±2.7) | * | * |
| Length of dorsal fin base length | 21.92 | 13.98-23.47 (16.77 ±2.6) | 17.18-25.39 (21.40 ±2.3) | 11.0-16.5 (13.6 ±1.3) | 14.6-20.1 (17.4 ±1.5) |
| Length of pectoral fin | 13.95 | 12.03-18.04 (14.09 ±1.6) | 13.56-21.00 (16.84 ±2.0) | 12.6-17.1 (15.4 ±1.0) | 16.1-20.2 (17.8 ±1.0) |
| Length of anal fin base | 14.54 | 9.47-15.98 (12.40 ±1.9) | 11.75-18.58 (14.87 ±1.7) | 8.9-11.3 (10.0 ±0.7) | 10.9-16.5 (13.8 ±1.6) |
| Length of pelvic fin | 12.57 | 6.40-13.77 (10.70 ±2.0) | 9.70-17.26 (12.29 ±2.1) | 8.1-12.1 (10.4 ±1.0) | 12.0-14.2 (12.7 ±0.6) |
| Length of upper caudal fin lobe | 18.89 | 17.85-25.70 (20.94 ±1.8) | 19.14-27.71 (22.94 ±2.3) | * | * |
| Distance between dorsal and caudal fin origin | 38.91 | 30.68-43.91 (36.15 ±3.1) | 26.79-65.06 (41.33 ±2.9) | * | * |
| Distance between pectoral and ventral fin | 26.04 | 23.81-29.51 (27.28 ±1.7) | 19.07-30.31 (23.91 ±2.8) | 20.6-26.9 (24.7 ±1.7) | 20.3-26.7 (20.3 ±1.8) |
| Distance between ventral and anal fin | 18.12 | 16.21-24.92 (20.02 ±2.6) | 14.97-28.17 (19.14 ±2.9) | 14.9-20.0 (16.5 ±1.3) | 12.4-17.4 (14.4 ±1.5) |
| Distance between anal and caudal fin | 30.21 | 21.89-30.86 (26.36 ±1.3) | 25.73-34.58 (30.40 ±2.7) | * | * |
| Caudal peduncle length | 17.54 | 15.47-21.49 (17.90 ±1.6) | 17.11-24.11 (20.41 ±1.4) | 16.3-18.7 (17.3 ±0.7) | 18.9-23.9 (20.9 ±1.2) |
| Minimum body depth | 15.88 | 13.64-17.26 (15.87 ±1.0) | 16.54-22.40 (19.27 ±1.4) | * | * |
| Maximum body depth | 29.90 | 29.48-37.08 (31.79 ±2.1) | 28.15-37.77 (33.68 ±2.0) | 19.2-24.5 (21.6 ±1.6) | 16.8-23.2 (19.9 ±1.8) |
| In percent of head length | | | | | |
| Head depth at eye | 65.56 | 60.16-79.83 (70.12 ±4.1) | 54.52-82.69 (68.90 ±3.8) | 59.0-67.0 (62.7 ±2.8) | 61.0-72.0 (64.0 ±2.9) |
| Eye diameter | 27.27 | 23.90-34.33 (30.00 ±2.1) | 22.77-43.41 (30.70 ±1.2) | 29.0-33.0 (30.1 ±1.4) | 30.0-35.0 (32.2 ±1.6) |
| Interorbital distance | 32.81 | 29.97-46.53 (38.08 ±2.7) | 25.81-38.27 (32.16 ±2.1) | 38.0-43.0 (40.4 ±1.5) | 38.0-44.0 (40.7 ±2.1) |
| Preorbital distance | 16.15 | 14.76-29.56 (21.50 ±3.1) | 11.41-32.15 (22.67 ±2.8) | * | * |
| Postorbital distance | 49.91 | 41.71-65.58 (50.95 ±2.9) | 41.26-63.57 (50.16 ±3.8) | 41.0-48.0 (45.3 ±1.9) | 40.0-45.0 (42.7 ±1.5) |
| Snout length | 7.89 | 7.19-16.34 (10.83 ±2.4) | 6.07-15.50 (9.97 ±2.0) | 17.0-23.0 (19.9 ±2.0) | 16.0-21.0 (18.5 ±1.4) |

*There is no data in Pfleiderer et al. (2014)

Morphological Analyses

A total of 40 *A. marassantensis* individuals were collected from Simenlik-Akgöl Lagoon (Samsun) on 20 May 2021 with an electro-fishing device. Fish were immediately fixed in 4% formaldehyde in the field and stored permanently in 70% ethanol. Identification of the specimens was based on the morphological characters following Pflieger et al. (2014), Yoğurtçuoğlu & Ekmekçi (2017) and Freyhof & Yoğurtçuoğlu (2020). Sex determination was based on external coloration of individuals. Weight was measured to the nearest 0.01 g. A total of 25 morphometric characters were measured from samples (Table 1). All measurements were made point to point taken on the left side of each specimen with a digital caliper by the same person according to Pflieger et al. (2014) and Kottelat & Freyhof (2007) (± 0.01 mm). Also, morphological data in Pflieger et al. (2014) were used for comparisons between specimens from Kızılırmak and Yeşilirmak drainages.

Results and Discussion

Türkiye is a very important fauna detection center due to its geological location. Periodic monitoring of ichthyofauna and updating fish fauna are very important due to global climate change. Our findings provide light on distribution of *A. marassantensis*. This study is very important as it is the first record of the species for the Yeşilirmak Lagoon Region (Simenlik-Akgöl Lagoon).

The general body shape of *A. marassantensis* from Simenlik-Akgöl Lagoon Lake is displayed in Figure 1. The minimum and maximum total lengths and weights of the samples are 32.63-45.26 mm and 0.60-1.89 g, respectively. And also, morphological data were offered in Table 1. Samples were sexed as 24 male and 16 female. The formulations of the fins are 9-10 branched rays in dorsal, 8-10 branched rays in anal, 14-16 rays in pectoral. Caudal fin is truncate or rounded. There is sexual dimorphism between males and females. Colouration varies between males and females (Figure 1). Males have 12-13 dark-brown lateral bars in flank. Pflieger et al.

(2014) indicated 8-13 dark-brown lateral bars in flank of males. These differences observed in morphology and morphometric measurements may be due to phenotypic plasticity and environmental variables. Also, in terms of fisheries management and biology, it is important to determine the phenotypic variations caused by environmental factors (Chen et al., 2015; Freire et al., 2017; Chavarie et al., 2021; Schroeder et al., 2022). Dorsal and ventral profiles convex between tip of snout and dorsal- and anal-fin origins, rarely straight; straight or slightly concave along caudal peduncle. There are no lateral bars in females. All characteristics of the captured samples were determined by comparing them with Pflieger et al. (2014). According to Pflieger et al. (2014), minimum and maximum total lengths are 28.3-42.6 mm, samples in present study are bigger. However, the percentage values of morphometric data at standard length and head length are similar with Pflieger et al. (2014).

Although records were given from Kızılırmak and Yeşilirmak Basins in previous studies on *A. marassantensis* (Hrbek et al., 2002; Pflieger et al., 2014; Yoğurtçuoğlu & Ekmekçi, 2017; Benzer, 2018; Benzer, 2021a; Benzer, 2021b; Gül & Atasagun, 2022), there is no record from Simenlik-Akgöl Lagoon, which is located in Yeşilirmak Basin, too (Figure 2-Table 2). The fact that the species was not found in previous studies carried out in the Simenlik-Akgöl lagoon may be related to the sampling gears. When the literature is examined, there are different studies about morphometry and phylogenetic of Aphaniid species (Wildekamp, 1993; Parker & Kornfield, 1995; Hrbek et al., 2002; Esmacili et al., 2014; Teimori et al., 2014; Benzer, 2018; Esmacili et al., 2020; Freyhof & Yoğurtçuoğlu, 2020; Kuyumcu, 2021). Molecular and morphometric investigations have corroborated taxonomic classification of *A. marassantensis* (Pflieger et al., 2014; Freyhof & Yoğurtçuoğlu, 2020).

Documenting biodiversity data is of crucial importance for a first step in conservation studies. Here the exact and most recent distribution data of endemic *A. marassantensis* is provided.

Table 2. Old and new records of *Aphanius marassantensis* from literature

| Drainage | Province | Coordinates | References |
|------------|------------------------------|------------------------------------|---------------------------------|
| Kızılırmak | Kayseri | 38° 40' 0" N 35° 17' 59" E | Fredie |
| Kızılırmak | Kayseri | 38° 41' 52" N 35° 19' 62" E | Hrbek et al. (2002) |
| Kızılırmak | Kayseri | 38°23'25" N 35°21'56" E | Freyhof et al. (2017) |
| Kızılırmak | Kırşehir | 38°59'15" N 34°06'58" E | Bardakci et al. (2004) |
| Kızılırmak | Ankara | 39° 09' 32.4" N 33° 36' 42.5" E | Yoğurtçuoğlu (2010) |
| Yeşilirmak | Çorum | 40° 22' N 35° 13' E | Yoğurtçuoğlu and Ekmekçi (2017) |
| Yeşilirmak | Çorum | 40° 23' N 35° 15' E | Yoğurtçuoğlu and Ekmekçi (2017) |
| Yeşilirmak | Çorum | 40° 26' N 35° 16' E | Yoğurtçuoğlu and Ekmekçi (2017) |
| Kızılırmak | Sinop | 42° 21' 24" N 35° 1' 5" E | Karsli and Aral (2010) |
| Kızılırmak | Ankara | 39° 0' 0" N 33° 01' 00" E | Yoğurtçuoğlu (2009) |
| Kızılırmak | Kırşehir | 39° 00' 00" N 33° 00' 00" E | Yoğurtçuoğlu (2009) |
| Yeşilirmak | Süreyyabey Dam-Yozgat | 35°28' N 39°55' E | Benzer (2018) |
| Kızılırmak | Karasu Brook | 39° 19' 55.63" N 34° 48' 12.77" E | Gül and Atasagun (2022) |
| Kızılırmak | Kanak Brook | 39° 30' 22.40" N 34° 48' 12.77" E | Gül and Atasagun (2022) |
| Yeşilirmak | Samsun-Simenlik-Akgöl Lagoon | 41°16' 41.952" N 36° 56' 29.868" E | This study |

**Figure 1.** General body shape of *Anatolichthys marassantensis* (a) Female (35.81 mm SL), (b) Male (30.30 mm SL), black bar represents 10 mm

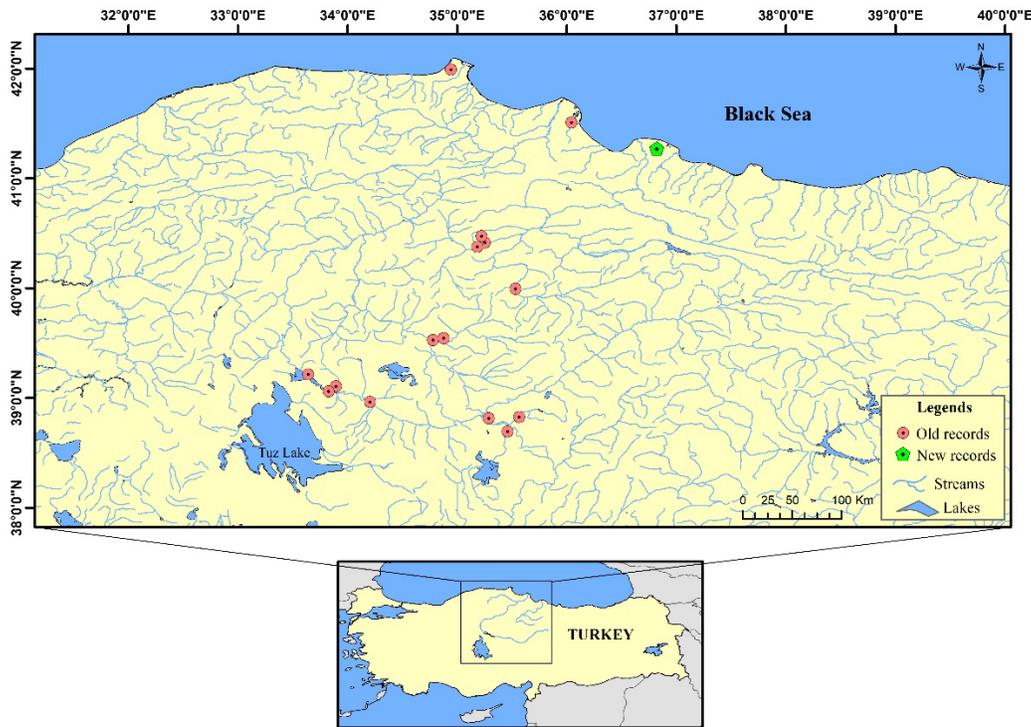


Figure 2. Distribution of *Anatolichthys marassantensis* in Kızılırmak and Yeşilirmak drainages

Conclusion

In this study, we report a new record of *A. marassantensis* from Simenlik-Akgöl Lagoon. The results of this study reveal that the existence of a new fish species has been recorded for the fish fauna of Simenlik-Akgöl Lagoon, and the distribution area of *A. marassantensis* has reached a different location in Yeşilirmak drainage.

Studies on fish populations is important from various viewpoints including evolution, ecology, behavior, conservation, water resource management, and stock assessment (AnvariFar et al., 2011). Unfortunately, changes in climatic conditions which are affecting the water regime, and anthropological activities are the main threats for the basin and lakes. It is obvious that all of these negative factors will have a detrimental impact on the species' range. The study of genetic stocks of endemic species and the identification of populations will lead to the appropriate and successful management of fish stocks. For all these reasons, a conservation strategy should be created for *A. marassantensis*.

Compliance with Ethical Standard

Conflict of interests: The authors declare that for this article they have no actual, potential, or perceived conflict of interests.

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