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The highest altitude occurrence of *Salariopsis fluviatilis* (Teleostei: Blenniidae) detected so far: Kızılırmak River-Black Sea basin (North of Türkiye)

by

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Abstract

A resident population of *Salariopsis fluviatilis* was discovered in the upper basins of the Kızılırmak River, the largest river in Türkiye. Samples with total lengths ranging from 22.24 mm to 90.86 mm were collected and examined. This discovery was the highest altitude record of both the genus *Salariopsis* and the species *S. fluviatilis*, with an altitude of 753 m. It was also reported for the first time from the Kızılırmak River-Black Sea basin (North of Türkiye). The obtained data were compared with records from different studies.

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1. Introduction

The family Blenniidae includes a large number of small benthic fishes. The vast majority are marine and found in tropical regions. Several species are known to enter brackish water or freshwaters in Southeast Asia, India, Africa, and South America (Kottelat, 2004). Recent taxonomic studies consider the freshwater species as a separate genus, *Salariopsis* (Duquenne-Delobel et al., 2022; Vecchioni et al., 2022). According to recent studies, five species belonging to the genus *Salariopsis* have been described. Of these species, except *Salariopsis fluviatilis* (Asso, 1801), all are endemic. *Salariopsis economidisi* (Kottelat, 2004) is endemic to the Lake Trichonis basin in Greece, *S. atlantica* (Doadrio et al., 2011) is endemic to the Sebou River in Morocco, *S. burcuae* (Yoğurtçuoğlu et al., 2023) is known from the Gulf of Antalya-Mediterranean basin (South of Türkiye) and eastwards to Jordan, and *S. renatorum* (Yoğurtçuoğlu et al., 2023) is known from the Upper Ceyhan drainage and a coastal stream in the Arsuz-Mediterranean basin (South of Türkiye) (Doadrio et al., 2011; Kottelat, 2004; Laporte, 2012; Yoğurtçuoğlu et al., 2023).

The freshwater blenny (*Salariopsis fluviatilis*) is a rare species that has shifted its entire life cycle to a new environment (from saltwater to freshwater; Zander, 1972). This species is also endemic to the subtropical Mediterranean, with a distribution unmatched among European freshwater fish (Froese & Pauly, 2013). These facts make it a valuable model species for regional environmental heritage, which could be lost without fundamental research and conservation efforts (Laporte et al., 2015). An important conservation effort was the development of molecular markers for the species. This advancement allowed for a better understanding of the genetic structure (Laporte et al., 2015) and the connectivity among river populations (Laporte et al., 2016a). The river blenny primarily inhabits the middle and lower reaches of rivers flowing into the Mediterranean Sea. In general, these systems experience strong seasonal fluctuations in water and flow levels, temperature, and resource availability. Several authors have investigated how freshwater fish species in Mediterranean rivers cope with these challenging conditions, particularly summer droughts (Encina & Granado-Lorencio, 1997; Oliva-Paterna et al., 2003; Oliveira et al., 2002; Pires et al., 2000; Ribeiro et al., 2000). In this context, the life history of the river blenny is of particular interest, as it provides parental care, a trait that distinguishes it from most other sympatric species (Vinyoles & De Sostoa, 2007). *Salariopsis fluviatilis* is a species widely distributed in the Mediterranean basin and some Atlantic drainages in the Iberian Peninsula. Additionally, *S. fluviatilis* exhibits high adaptability to varying salinity levels and the development of alternate reproductive strategies influenced by environmental conditions. It is believed that phenotypic plasticity promotes gene flow between populations residing in various habitats and the colonization of new environments. Due in part to the phenotypic plasticity of these features, *S. fluviatilis* is found in a wide variety of freshwater settings, separated by high salinity (seawater), and dispersed throughout the Mediterranean basin (Laporte et al., 2016a, 2016b). The *S. fluviatilis* population was assessed as least concern (LC). The species has widespread water areas in Türkiye (IUCN, 2016). They are widely found in the inland waters along the Western Anatolian and Black Sea coasts of Türkiye (Bostancı et al., 2016, 2017; Gaygusuz et al., 2006; Genç & Yılmaz, 2023; İlhan et al., 2013; İnnal, 2019; Özdemir et al., 2015; Özuluğ et al., 2005; Saç et al., 2021; Uğurlu & Polat, 2006; Uğurlu et al., 2009).

When the studies and records were examined, it was determined that other endemic species of the *Salariopsis* genus (*S. renatorum, S. burcuae, S. economidisi, S. atlantica*) and *S. fluviatilis* were distributed in regions at sea level. The species has also been found in alpine lakes such as Annecy (447 m), Aiguebelette (390 m), Léman (372 m), Bourget (232 m), Maggiore (193 m), and Garda (65 m). Lake populations tend to exhibit smaller body sizes (Laporte et al., 2013) and reduced sexual dimorphism (Laporte et al., 2018) compared to river populations. However, the species' first record and the highest altitude above sea level of the genus and species detected so far in the largest river of Türkiye the Kızılırmak River are presented in this study. In this context, the aim of the study is to determine the ecological characteristics of the Kızılırmak River population and to provide information about the distribution and habitat preferences of the species in Türkiye. This new record contributes to a better understanding of the distribution limits of the species in Türkiye, while also providing important data for the protection of freshwater ecosystems in the region.

2. Materials and methods

The Kızılırmak River is the most important river in Türkiye. It provides potable water and is used for various agricultural, industrial, and recreational purposes. It is also Türkiye's longest river, with a length of 1355 km. Springing from Kızıldağ, Sivas, it flows across the central Anatolian plain, cuts through the Pontid Mountains, and disembogues the Black

Sea near the city of Samsun. Its catchment area is 78.180 km^2. The name Red River is derived from the high concentration of suspended clay particles that causes its characteristic reddish color (Akbulut et al., 2009; DSI, 1986). It has been reported that the Kızılırmak River receives a high amount of pollutants in the North and Middle Basin areas due to the dense population and, consequently, domestic wastewater. In this region, wastewater from most industrial areas is discharged into the river or its tributaries without any treatment (Bakan et al., 2010).

Fish specimens (Fig. 1) were collected from Kızılırmak River–Kesikköprü Bridge (Kırşehir, Türkiye; 39°23′2.96″N, 33°24′37.84″E) (Fig. 2) at the Kızılırmak River–Kesikköprü Bridge (Fig. 3) during July 2021. Starting from Kesikköprü Bridge, the Kızılırmak River flows approximately 600 km in a northeast direction until it reaches the Black Sea near the district of Bafra in Samsun. This distance is an approximate measurement, considering the river's meanders and flow path. The salinity of the sampling area is 0.874 PSU, the pH is 7.95, electrical conductivity (EC) is 1751 μS/cm, dissolved oxygen is 6.85 mg/L, depth is 1 m, and water temperature is 22.1°C. The bottom structure of the sampled locality and its surroundings consists of sand dunes and small stony-gravel areas. The specimens were fixed in a 4% formaldehyde solution for further examination and deposited in the Inland Fish Collection at the Eğirdir Fisheries Faculty of Isparta University of Applied Sciences under catalog number IFC-ESUF 06-0020. Measurements were

Figure 1

Salariopsis fluviatilis, IFC-ESUF 06-0020, 64.21 mm SL, female; 77.58 mm SL, male.

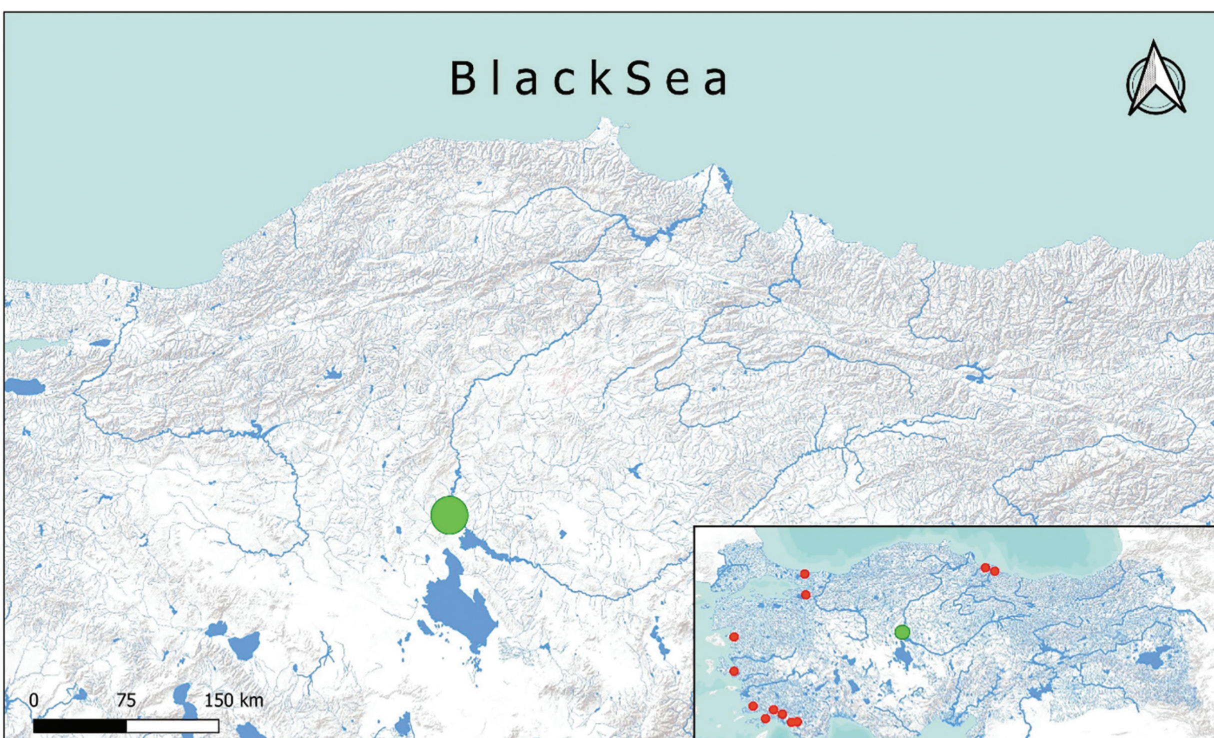

Figure 2

Map showing the location of fish sampling and other localities of *Salariopsis fluviatilis* (green circle: new record, red circles: old records).

Figure 3

The locality where the new record is issued (Kesikköprü Bridge-Kızılırmak River, Kırşehir-Türkiye).

recorded to the nearest millimeter using a digital caliper. The measurements were compared to those of Yoğurtçuoğlu et al. (2023). The map (Fig. 2) was generated using QGIS version 3.34.11-Pi, accessible at https://www.qgis.org

3. Results and discussion

The morphometric characters of *S. fluviatilis* specimens are shown in Table 1. The diagnostic characters and morphometric measurements of the specimens we obtained are similar to the measurements in taxonomic studies conducted with *S. fluviatilis* specimens obtained from different habitats in Türkiye (Bostancı et al., 2016; Onaran et al., 2006). In the individuals we examined, the supraocular tentacle is branched. *Salariopsis fluviatilis* differs from *S. renatorum* (supraocular tentacle unbranched), which is widespread in Türkiye, by having branched supraocular tentacles. Long supraocular tentacle that typically overlaps the ninth circum-orbital sensory pore; little black dots on the cheek that are typically arranged in rows, frequently forming a wide diagonal band that extends from the lower edge of the eye backwards (according to Yoğurtçuoğlu et al., 2023, *S. burcuae*; short supraocular tentacle, typically does not overlap the ninth circum-orbital sensory pore; numerous tiny black dots on the cheek that are not arranged in bands or rows, *S. renatorum*, Black lateral line pores; no black spots on the cheek or upper portion of the flank). A comparison was made with the morphometric data of the newly identified species *S. burcuae* and *S. renatorum* in the study conducted by Yoğurtçuoğlu et al. (2023). It was observed that *S. fluviatilis* differed from the two newly identified species with countable characters rather than morphometric data (see Table 1).

Localities with similar traits may indicate that the species is subject to stable genetic or environmental influences in these characteristics. For example, the similarity in body length across populations in a

Table 1

Morphometric characters of the *S. fluviatilis*-IFC-ESUF 06-0020 collected from an Kızılırmak River (M: Male/*n* = 3, F: Female/*n* = 5, SL: Standart length, HL: Head length, SD: standard deviation).

	M ± SD	F ± SD	(M + F) ± SD	[1]*S. renatorum*	[1]*S. burcuae*
Standard length (min–max)	55.22–90.86	59.69–78.83	55.22–90.86		
Percent of SL					
Head length	29.98 ± 2.91	26.78 ± 1.71	27.28 ± 2.31	28.6	27.4
Body depth	33.50 ± 2.52	31.81 ± 2.06	32.44 ± 2.29	-	-
Predorsal distance	30.30 ± 1.87	28.97 ± 1.85	29.47 ± 1.86	29.1	27.5
Prepelvic distance	27.26 ± 2.18	25.66 ± 2.16	26.26 ± 2.17	23.3	23.6
Preanal distance	58.92 ± 3.12	60.56 ± 2.88	60.45 ± 3.00	57.0	55.0
Pectoral fin origin to anal fin	33.81 ± 2.77	37.76 ± 2.80	36.28 ± 2.79	-	-
Pelvic fin origin to anal fin	35.21 ± 2.97	38.84 ± 3.23	37.48 ± 3.10	33.6	31.3
Dorsal fin depth	13.38 ± 1.36	11.72 ± 1.26	12.34 ± 1.31	11.4	10.2
Dorsal fin length	66.05 ± 1.63	68.32 ± 1.30	67.47 ± 1.47	70.9	69.9
Anal fin depth	11.37 ± 0.73	12.01 ± 0.32	11.77 ± 0.53	-	-
Anal fin length	42.67 ± 1.93	40.12 ± 1.87	41.07 ± 1.90	38.9	41.0
Pectoral fin length	23.24 ± 3.94	26.57 ± 4.55	25.32 ± 4.25	24.2	22.4
Pelvic fin length	14.45 ± 2.26	17.37 ± 2.47	16.28 ± 2.37	17.3	15.8
Caudal peduncle length	7.09 ± 1.44	7.77 ± 1.49	7.52 ± 1.47	7.2	8.2
Caudal peduncle depth	10.07 ± 0.78	9.73 ± 0.91	9.8 ± 0.85	8.9	9.0
Percent of HL					
Snout length	25.05 ± 3.57	24.58 ± 4.35	24.75 ± 3.96	27.8	31.9
Eye diameter	20.48 ± 2.70	17.05 ± 1.37	18.33 ± 2.04	22.4	20.5
Interorbital distance	35.26 ± 3.63	31.87 ± 1.53	33.14 ± 2.58	-	-
Head width (at operculum)	68.68 ± 4.31	64.42 ± 4.14	66.02 ± 4.23	-	-
Head width (at interorbital)	50.43 ± 5.88	39.16 ± 4.35	43.38 ± 5.12	-	-
Head depth (at interorbital)	62.71 ± 6.71	52.18 ± 4.06	56.13 ± 5.39	-	-
Head depth (at occipital)	99.08 ± 8.70	83.69 ± 2.77	89.46 ± 5.73	-	-
Internostril distance	16.81 ± 3.23	11.44 ± 1.43	12.55 ± 2.33	-	-
Mouth width	32.93 ± 3.19	25.88 ± 1.62	28.52 ± 2.41	-	-

[1]Yoğurtçuoğlu et al. (2023).

specific locality could be associated with similarities in food resources and ecosystem structure in that area. Variations in body size across different habitats may reflect the species' adaptive capacity and its responses to environmental factors. If differences in body size are observed at high-altitude localities, this may be interpreted as an adaptation to cooler water temperatures or lower oxygen levels. Gene flow between populations living in various settings and colonization of new environments are thought to be facilitated by phenotypic plasticity. Therefore, the phenotypic plasticity of these features may contribute to the occurrence of *S. fluviatilis* in a wide variety of freshwater settings that are dispersed throughout the Mediterranean basin and separated by high salinity (seawater). It is possible that: (1) migrants have been able to reach new estuaries by acclimating to salt water; (2) shape acclimation has improved survival rates in a variety of lotic environments; and (3) various reproductive strategies have maximized the number of offspring produced in various freshwater conditions (Laporte et al., 2016b). Laporte et al. (2016b) conducted an experimental study to find the reasons for the non-random relationship bet ween an environmental factor and a specific trait, and investigated whether the relationship could be explained by phenotypic plasticity. The results of this study showed that fish at higher water speeds exhibited a more slender body shape and longer anal and caudal fins. These results indicate a high degree of morphological plasticity in

Table 2

Occurrence of *S. fluviatilis* in different habitats and altitudes.

Locality	Country	Altitude (m)	Coordinates
Kızılırmak River-Kırşehir (*This study*)	Türkiye	753	39°23′52.96″N 33°24′37.84″E
Karadere Creek-Muğla	Türkiye	1	36°20′24.12″N 29°14′40.66″E
Eşen River-Muğla	Türkiye	125	36°39′02.59″N 29°21′57.88″E
Dalaman River-Muğla	Türkiye	28	36°49′25.65″N 28°48′21.98″E
Köyceğiz Lake-Muğla	Türkiye	0	36°57′31.33″N 28°40′28.23″E
Hisar Creek-Muğla	Türkiye	5	36°48′34.06″N 28°07′47.75″E
Akyol Creek-Muğla	Türkiye	13	37°13′40.78″N 27°41′04.01″E
Şaşal Creek-İzmir	Türkiye	65	38°11′58.63″N 27°08′09.31″E
Madra Stream-Balıkesir	Türkiye	21	39°13′05.98″N 26°49′08.98″E
İznik Lake-Bursa	Türkiye	83	40°23′45.74″N 29°40′49.11″E
Şile Creek-İstanbul	Türkiye	6	41°09′27.13″N 29°40′14.39″E
Yeşilırmak River-Samsun	Türkiye	3	41°20′48.18″N 36°38′49.81″E
Miliç Creek-Samsun	Türkiye	6	41°10′20.83″N 37°02′11.82″E
Ait Chaffa River[1]	Algeria	0	36°52′58.20″N 4°30′34.46″E
Boughzazene River[2]	Algeria	1	36°38′22.25″N 5°20′23.21″ E
Kournas Lake[3]	Greece	16	35°19′49.74″N 24°16′34.42″E
Rihios estuary[4]	Greece	0	40°40′35.39″N 23°41′33.68″E
Abatescu (east coast)[2]	Corsica-France	8	41°58′33.07″N 9°24′00.24″ E
Fangu (west coast)[2]	Corsica-France	162	42°22′46.28″N 8°45′17.31″ E
Fium Orbu (east coast)[7]	Corsica-France	23	42°02′24.43″N 9°22′00.40″ E
Gravona (west coast)[7]	Corsica-France	15	41°56′15.52″N 8°48′37.98″ E
Annecy (alpine lake)[2]	France	444	45°53′53.27″N 6°08′03.02″ E
Tech River[2]	France	20	42°35′06.25″N 2°58′43.12″ E
Var River[2]	France	0	43°39′06.23″N 7°12′00.09″ E
Fluvià River[2]	Spain	4	42°10′41.12″N 3°04′29.02″ E
Sègre River[2]	Spain	247	41°52′32.30″N 0°52′31.38″ E
Júcar Basin[5]	Spain	47–400	-
Lake Garda[3]	Italy	99	45°42′30.11″N 10°45′43.35″E
Bañolas Lake[6]	Spain	172	42°07′00.36″N 2°45′15.64″E
Matarraña River[6]	Spain	75	41°21′38.93″N 0°17′17.01″E
Albufera Lagoon[6]	Spain	0	39°19′17.32″N 0°19′26.35″W
Cabriel River[6]	Spain	579	39°32′26.24″N 1°30′22.08″W
Ruidera Lakes[6]	Spain	741	38°59′57.67″N 2°55′40.20″W
Zújar River[6]	Spain	271	38°56′08.43″N 5°34′10.12‴W
Verde River[6]	Spain	228	36°35′56.32″N 4°56′23.65″W
Guadaíza River[6]	Spain	166	36°31′59.90″N 5°02′58.60″W

[1]Baikeche et al. (2021).
[2]Laporte et al. (2015).
[3]Neat et al. (2003).
[4]Koutrakis and Tsikliras (2003).
[5]Hernandez et al. (2000).
[6]Méndez et al. (2019).
[7]Laporte et al. (2014).

river populations of *S. fluviatilis* and suggest that the previous relationship between morphology and water speed observed in the field may be largely due to environmental determinism. *S. fluviatilis*, a freshwater blenny that inhabits lakes and rivers throughout the Mediterranean, exhibits significant sexual dimorphism in terms of size, shape, and behavior (i.e., females require more swimming during the breeding season, while males have larger bodies and heads). In our study, sexual dimorphism is also seen between male and female individuals. As mentioned, males having larger heads and larger bodies are more evident in river populations than in lake populations. In our study, the head length of male individuals was determined as 29.98% (vs 26.78%), body depth as 33.80% (vs 31.81%), eye diameter as 20.48% (vs 17.05%), interorbital distance as 35.26% (vs 31.87%), head width (at operculum) as 68.68% (vs 64.42%), head width (at interorbital) as 50.43% (vs 39.16%), head depth (at interorbital) as 62.71% (vs 52.18%), and head depth (at occipital) as 99.08% (vs 83.69). These data are consistent with the aforementioned opinion. In order to ascertain the trade-offs between natural and sexual selection that underlie the variance in sexual dimorphism in the species, Laporte et al. (2018) examined the differences in sexual dimorphism in size and form among populations in lake and river habitats. The study's findings indicate that: (i) there were differences in sexual size dimorphism based on Rensch's rule (bigger individuals in rivers had higher sexual size dimorphism) and (ii) there was a decline in form divergence between male and female populations in lakes. This implies that the relative significance of sexual selection in the manifestation of sexual dimorphism within the species is influenced by the environmental differences between lake and river habitats (e.g., resource constraints, hunting pressure, water velocity).

The coordinates of the habitats in Türkiye and the Mediterranean countries where it is distributed and the altitudes of the habitats above sea level are given in Table 2. In this study, the detection of *S. fluviatilis* in the Kızılırmak River represents the highest altitude record of the species in Türkiye. Furthermore, comparing the population in the Kızılırmak River with those in other localities in Türkiye provides valuable insights into the distribution dynamics of this species within the country. Comparisons across different localities, in particular, offer new perspectives on the habitat preferences, environmental tolerances, and regional adaptation capacities of *S. fluviatilis*.

Our findings suggest that the Kızılırmak River provides a potentially suitable habitat for *S. fluviatilis*, with ecosystem characteristics diverse enough to meet the species' needs. Comparisons with other localities in Türkiye contribute to a more comprehensive understanding of the species' ecological adaptations, underscoring the significance of the Kızılırmak River ecosystem in terms of biodiversity. Differences among populations at various altitudes and ecological conditions shed light on the species' resilience to environmental stress factors and adaptive capacities. As shown in Table 2, *S. fluviatilis* generally prefers aquatic habitats at sea level. The species' distribution in Türkiye is mostly concentrated at sea level; however, in Europe, it has been observed that populations in one or two localities in France (100–579 m) and Spain (741 m in Ruidera Lakes) are found at around 500–700 m, indicating *S. fluviatilis*' preference for these regions. In addition, in the Kızılırmak River, as in localities in France and Spain, regular populations—from small to large adult sizes (22.24–90.86 mm standard length)—have been observed. This is an indication that the population is not observed randomly here, but forms regular populations in this habitat. In addition, in a recent sampling in the same region (November 2024), in an area of approximately 150 m, individuals between 40 mm and 130 mm in standard length were encountered (personal opinion of Zafer Alparslan, MSc).

This study presents the first record of *S. fluviatilis* in the Kızılırmak River by comparing its population with populations from other locations in Türkiye. In addition, this population represents the highest altitude occurrence of the species compared to its distribution throughout the Mediterranean. The Kesikköprü habitat of the Kızılırmak River, where the species is found at the highest point, is a gravelly and occasionally sandy area with a depth of approximately 1 m. The water flow rate is generally at a medium flow throughout the year, but it also carries the risk of flooding by flowing at high speeds in heavy rainfall. When the water quality values are considered as the general habitat, it can be said to be an ideal habitat for the survival of the *S. fluviatilis* species. At the same time, the vegetation-covered areas surrounding the river like a belt also serve as a shelter and protection for the species. These findings provide valuable information about the ecological tolerance and habitat adaptation of the species. The presence of *S. fluviatilis* in this river reflects the effect of environmental factors such as water quality, substrate composition, and flow rate on the dynamics of its population.

The substrate of the area where the species has been identified resembles a river habitat with shallow and wide beds formed by small gravel stones. This closely reflects the species' general habitat. This habitat represents an area in the upper reaches of the Kızılırmak River and is located at an altitude of 753 m above sea level. Starting from Kesikköprü Bridge, the Kızılırmak River flows approximately 600 km in a northeast direction until it reaches the Black Sea near the district of Bafra in Samsun. Similarly, in a study conducted by Baikeche et al. (2021) in Western Kabylia, *S. fluviatilis* was found to have a limited distribution in specific river systems, being observed only in clean water sources. This suggests that the Kızılırmak River population likely has similar water quality requirements, and that the diversity of the habitat should be preserved. The freshwater blenny is considered endangered or vulnerable in many countries, including Croatia, Italy, Spain, France, and even Türkiye. The reasons for the species' endangered status can be explained by its sensitivity to water pollution, the introduction of invasive fish species, changes and imbalances in water velocity, substrate changes, and severe drought (Laporte et al., 2014).

The Kızılırmak population, in line with the study by Laporte et al. (2015) examining the genetic structure of *S. fluviatilis* in the Western Mediterranean basin, could be an important source for evaluating the genetic diversity of the species and population differentiation. In their study, Laporte et al. (2015) noted that genetic groups in the Mediterranean region originated from isolated populations during glacial periods. The Kızılırmak River population can also be evaluated through genetic comparisons with other populations in Türkiye to determine whether it belongs to one of these groups.

Vinyoles and De Sostoa (2007) noted that under Mediterranean-type climate conditions, *S. fluviatilis* exhibits traits such as rapid growth, early reproduction, and multiple spawning, suggesting that these adaptations may have developed as a response to environmental changes. Similarly, the Kızılırmak population's adaptation to high-altitude, cold, and fast-flowing water conditions demonstrates the species' capacity for adapting environmental stresses. These adaptations may provide valuable insights into the species' sensitivity to changes in water quality and habitat fragmentation.

In the study by Zogaris et al. (2015), which highlighted uncertainties regarding the presence of *S. fluviatilis* in Cyprus, it is emphasized that human activities and habitat degradation can negatively impact the species' distribution. The lessons drawn from this study are important for the conservation of the Kızılırmak population. In particular, the preservation of river ecosystems and the monitoring of water quality may be vital for the sustainability of this population. As Zogaris et al. (2015) noted, factors such as overuse of water resources and pollution can lead to the isolation of species in small populations and even to local extinctions.

Research conducted by İnnal (2019) along the Mediterranean coasts indicated that *S. fluviatilis* tends to concentrate in brackish water systems and shows sensitivity to environmental changes. İnnal's findings provided important insights for evaluating the threats that the species may face in freshwater systems like the Kızılırmak. This highlights the need for populations to develop resilience against environmental pressures, particularly changes in water quality and habitat loss.

In the study by Hernandez et al. (2000), it was determined that the species is found in habitats with significant variations in terms of altitude, depth, stream velocity, substrate composition, and limnological parameters. A study in the Júcar River Basin showed that *S. fluviatilis* populations are concentrated in areas with higher discharge and clean waters and that pollution has negative effects on the population. The research specifically revealed that population density increased in areas with low coliform levels. The species' presence in the study area seems to be more dependent on water quality than on habitat variables. Urban pollution, as measured by coliform counts and BOD5, has a negative impact on the species, which is found only in the Júcar River (Spain) and some of its tributaries. Freeman et al. (1990) also found that *S. fluviatilis* demonstrates a high tolerance to a wide range of environmental conditions in the Matarraña River. Côté et al. (1999) clearly highlighted the importance of the presence of stones for nesting and the negative impact caused by gravel extraction. In this context, the lower pollution levels in the high-altitude regions of the Kızılırmak River may suggest that the population can sustain itself more healthily in these areas.

Wagner et al. (2021), in their study on the genetic diversity of *S. fluviatilis*, suggested that populations in the Mediterranean basin have diversified due to paleogeographic events and may have developed local adaptations. The study emphasizes that *S. fluviatilis* populations are genetically differentiated, but some populations are under threat due to anthropogenic impacts. In this context, the conservation of the Kızılırmak population is crucial for maintaining the species' genetic and ecological diversity in Türkiye.

The study by Neat et al. (2003) examined the behavioral and morphological differences exhibited by *S. fluviatilis* in different habitats, revealing distinct adaptive differences between lake and river populations. Specifically, the larger reproductive investment and increased sperm production observed in river populations were interpreted as a response to adaptation to fast-flowing waters. Similarly, it can be suggested that the population in the Kızılırmak River has also adapted to high-altitude, fast-flowing waters. These adaptations may have developed as a response to the challenging conditions of the Kızılırmak ecosystem.

The study by Alp and Kara (2007) on the Ceyhan River reported that *S. fluviatilis* populations are limited to low-altitude habitats, particularly concentrating in areas below 750 m. The presence of the population in the Kızılırmak River at a higher altitude provides new insights into the species' adaptive capabilities. This finding is important for evaluating *S. fluviatilis'* capacity to adapt to climatic changes and habitat diversity.

The study by Méndez et al. (2019) examined the genetic structure of *S. fluviatilis* populations in the Iberian Peninsula, revealing regional differences in the species. It was emphasized that these differences should be considered in the conservation of genetic diversity. Similarly, genetic analyses between the Kızılırmak population and other populations in the Mediterranean basins could be useful for understanding the level of genetic diversity among populations in different river basins in Türkiye. These analyses could help identify the intra-species genetic differences of the Kızılırmak population and determine its conservation needs.

The species *Salariopsis burcuae* and *Salariopsis renatorum* discovered by Yoğurtçuoğlu et al. (2023) in eastern Türkiye, despite being closely related to *S. fluviatilis*, exhibit distinct morphological and genetic traits, highlighting species divergence. These new discoveries reveal phylogenetic differences between *S. fluviatilis* and other freshwater blenny species and demonstrate that geographic barriers contribute to the speciation process. Similarly, a more comprehensive morphological and genetic analysis of the Kızılırmak population could reveal how much this population has diverged from other populations in Türkiye and whether it might potentially represent a different ecotype.

In conclusion, comparing the *S. fluviatilis* population in the Kızılırmak River with those from other localities in Türkiye and other Mediterranean countries allows for a better understanding of the species' ecological requirements and its sensitivity to environmental factors. These findings are significant for both the conservation of the species and the sustainable management of the Kızılırmak ecosystem. Future research, by examining parameters such as population density, habitat preferences, and growth characteristics in more detail, may contribute to a better understanding of *S. fluviatilis'* responses to environmental changes. The results of this study indicate that the Kızılırmak River serves as an important habitat for *S. fluviatilis* populations, emphasizing the need to preserve water quality and habitat integrity to ensure the population's conservation and long-term sustainability. It is recommended that additional studies be conducted in the future to better understand the species' distribution dynamics and assess its genetic structure. Such studies could clarify the genetic, ecological, and biological relationships of *S. fluviatilis* with other localities in Türkiye.

This new record represents a notable example of the biological diversity of the Kızılırmak River ecosystem and provides an important reference point regarding the species' presence in Türkiye's inland waters. Furthermore, this finding highlights the importance of future monitoring studies to assess the potential impacts of environmental threats such as climate change, water pollution, and habitat loss on the species' distribution. The conservation of the Kızılırmak River and its surrounding habitats could be a critical step in understanding the effects on the populations of sensitive species such as *S. fluviatilis*. In conclusion, these findings offer a new perspective for understanding both the biological diversity of Türkiye's inland water ecosystems and the regional distribution dynamics of species. The findings emphasize the importance of habitat conservation and water quality monitoring for the sustainable management of this population, suggesting that long-term monitoring studies are needed for the species, including comparisons with other localities in Türkiye.

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