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# Northernmost Locality Record of the Near Eastern Fire Salamander, *Salamandra infraimmaculata* (Martens, 1885) (Amphibia: Salamandridae) in Türkiye

**Hatice Özkan [1,a], Ufuk Bülbül [1,b,*]**

[1] *Department of Biology, Faculty of Science, Karadeniz Technical University, Trabzon, Türkiye.*
**Corresponding author*

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**ABSTRACT**

We provided a new locality record of *Salamandra infraimmaculata*, which is distributed in Türkiye, Syria, Lebanon, Iraq, Iran, and Israel. Five juvenile individuals belonging to the species were recorded from Yoncabayırı village located in the İmranlı district of Sivas province, Türkiye. This is the evidence for the northernmost locality of *S. infraimmaculata*. The new locality record shows that the distribution of the species may extend along the branches of the Kızılırmak River and Tozanlı and Kelkit streams. Future field observations to be performed in the northern districts of Sivas and neighboring provinces to the north may extend the distribution of the species in Türkiye. Morphometric measurements and color-pattern characteristics of the specimens of the species from the new locality were described according to the subspecies distinction. SVL ranged between 63.14 and 78.43 mm in the juveniles of *S. infraimmaculata*. The color-pattern characteristics of the specimens from the Yoncabayırı population were found similar to the color-pattern features reported in other studies for *S. i. orientalis* subspecies. The specimens caught in Yoncabayarı had the presence of small yellow spots on the dorsal, which corresponds to the general characteristic of the subspecies.

***Keywords:*** Distribution, Morphometric measurement, İmranlı, Population, Sivas.

[a] *haticeozkan@ktu.edu.tr* *https://orcid.org/0000-0002-7810-864X*
[b] *ufukb@ktu.edu.tr* *https://orcid.org/0000-0001-6691-6968*

## Introduction

The Near Eastern fire salamander, *Salamandra infraimmaculata* which is the largest species in the Salamandra genus, inhabits coastal mountainous forests from southeastern Anatolia to Israel (Türkiye, Syria, Lebanon, Iraq, Iran, and Israel) where it is threatened by habitat destruction. The species breeds during the coolest months of the year, although the subspecies *S. i. orientalis* and *S. i. semenovi*, which are restricted to high altitudes, are active during the summer months. It is entirely terrestrial, with only the females making brief visits to water to deposit their larvae [1].

A female lays 20-40 or more larvae in the water. The habitat of this nocturnal species is not far from water. The species inhabits humid forests and woodlands in mountainous and hilly regions, often found beneath leaves, between rocks, or in holes. Their habitat typically includes a nearby freshwater source [2]. *S. infraimmaculata* is classified in the Least Concern (LC) category in the IUCN Red List. The species is distributed between altitudes of 180-2000 m [3]. Although *S. infraimmaculata* is classified in the LC category, it is threatened by pesticide pollution, predation by introduced fish, residential development, transportation and service corridors, human intrusions and disturbance, climatic change (droughts), and habitat destruction, notably the damming of breeding streams [1, 3].

The species was described from Syria in 1885. There are three different subspecies of the species. *S. i. infraimmaculata* is distributed in the Hatay province of Türkiye, Syria, Lebanon, and northern Israel, while *S. i. orientalis* is found in southeastern Türkiye, and *S. i. semenovi* occurs in easternmost Türkiye, western Iran, and northern Iraq [1, 4-11].

Previously, the Turkish specimens in the Salamandra genus were accepted as the Common fire salamander, *Salamandra salamandra* (Linnaeus, 1758) [12-17]. On the other hand, the Kemaliye (Erzincan) population was assigned to *S. s. infraimmaculata* [18]. Later, this subspecies was raised to the full species level based on blood-serum protein patterns. The whole Turkish populations of the species were classified as *Salamandra infraimmaculata* [5, 19]. Molecular phylogenetic findings confirmed this classification [6, 7, 20, 21]. Subsequently, the differences in color-pattern of the three subspecies distributed in Türkiye were reported [10].

In Türkiye, the distribution of *S. infraimmaculata* is known among the Eastern (Erzincan, Tunceli, Bitlis, Bingöl, and Malatya provinces) Southern (Adana, Mersin, Hatay, Kahramanmaraş, and Osmaniye provinces), Southeastern (Gaziantep, Şanlıurfa, Adıyaman, and Diyarbakır provinces) and Central Anatolia regions (Niğde and Konya provinces) [2, 4, 22]. The distribution and taxonomic status of *S. infraimmaculata* are not clear for Turkish populations [11]. Scientific studies continue to solve this complexity. In addition to these data, the catalogue of Amphibia and Reptilia specimens in the Çanakkale Onsekiz Mart University Zoology Museum was reported and the collection of *S. infraimmaculata* from Divriği district of

Sivas province was stated without providing any locality details [23].

This study provides information on the distribution of *S. infraimmaculata* in a second district (İmranlı) of Sivas province. The new location (Yoncabayırı village of İmranlı district) is the northernmost locality record of the species in Türkiye. With the record of the present study, the known distribution area of the species has been extended about 40 km northward. This new record is an indication that the species can be found in other districts in the north of Sivas and neighboring provinces in the north of the province.

## Materials and Methods

### *Sampling*

A total of 5 juveniles of *Salamandra infraimmaculata* (Figure 1) were observed in Yoncabayırı village (N: 39° 38′ 19″ E: 38° 16′ 19″, 1606 m a.s.l.) of İmranlı district, Sivas province (Figure 2) between 4 April and 8 August 2022.

(a)

(b)

(c)

(d)

Figure 1. The juvenile individuals of *Salamandra infraimmaculata* observed in the Yoncabayırı population

In this locality, where the continental climate prevails, the habitat is composed of rocks, stabilized roads, and occasionally sparse trees. Vegetation consists of trees such as poplar (*Populus* sp.), willow (*Salix* sp.), walnut (*Juglans* sp.), oak (*Quercus* sp.), and herbaceous plants such as thyme (*Thymus* sp.) and gum tragacanth (*Astragalus* sp.).

The salamanders described in this study were observed in a water reservoir used by the villagers to store water, during a day excursion between 13.00-18.00. The geographic locations of the specimens were recorded with a GPS receiver (Garmin eTrex 20). The salamanders were caught by hand, and the morphometric measurements were performed without any anaesthesia procedure on the salamanders using a digital caliper (Mitutoyo, Kawasaki, Japan) with an accuracy of 0.01 mm. After the morphometric measurements were taken and the color and pattern characteristics of the specimens were recorded in the field, the salamanders were released back to their habitat.

According to our observations, other reptiles shared their living areas with *S. infraimmaculata* are *Pelophylax ridibundus*, *Bufotes viridis*, *Lacerta media*, *Eirenis modestus*, and *Testudo graeca* in Yoncabayırı.

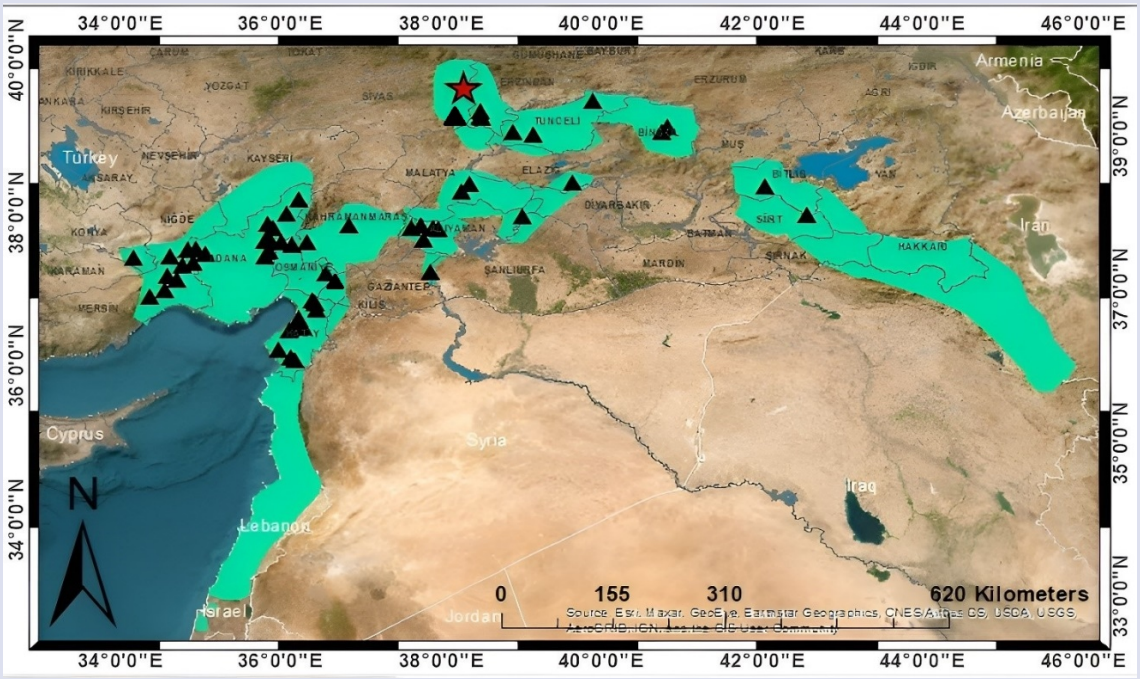


Figure 2. Map showing the localities of *Salamandra infraimmaculata*. The black triangles indicate localities previously reported in the literature and the red colored star shows the new locality (This map has been modified using the IUCN map and the locations of *S. infraimmaculata* reported in the literature [4, 10, 11, 17, 22, 23, 24-29]).

### *Morphological Data*

All morphological measurements are given in Table 1. The following morphometric characteristics were evaluated in a manner, similar to the previous studies [4, 11, 14] related to *Salamandra infraimmaculata*: Total body length (TBL), tip of snout to tip of tail; body length (LCP), length from snout to anterior end of cloaca opening; snout-vent length (SVL), tip of snout to posterior end of cloaca opening; tail length (TL), length from posterior end of cloaca opening to tip of tail; forelimb length (FLL); hindlimb length (HLL); distance between fore and hind limbs length (DFHL); head length (HL), distance from snout to gular fold; head width (HW); parotid length (PL); parotid width (PW); distance between anterior of each parotids (DAP). The ratios of TBL/TL, TL/SVL, DFHL/SVL/, PL/HL, PW/HW, PW/PL and HW/HL were used to comparison. The morphometric measurements and ratios were compared to previously published data.

The color and pattern characteristics of the specimens were determined according to subspecies distinction. *S. i. infraimmaculata* is distinguished by its mostly large yellow dots (solid larger flecks) spread throughout the whole body, except the belly. In general, there are four yellow spots on the head (One on each paratoid and one above each eye). *S. i. orientalis* closely resembles *S. i. infraimmaculata* in appearance (having the larger broad solid flecks), except for the presence of small yellow spots covering its entire body, excluding the belly. *S. i. semenovi* is characterized by rose-like, circular spots (typical scrolled pattern of yellow rings) covering its entire body and having semicircles. The head exhibits a rather rounded shape [10, 30, 31].

## Results and Discussion

SVL ranged between 63.14 and 78.43 mm in the juveniles of *S. infraimmaculata*. TBL changed from 96.18 mm to 113.52 mm. LCP varied between 60.02 and 74.27 mm. Other measurements and ratios of the specimens are given in Table 1.

In all specimens, the ground color of the upper part of the head was black and there was a yellow spot on the upper part of each eye (Figure 1). These spots above the eyes were not in contact with each other. The parotid glands were devoid of pigmentation, forming a pale dark spot. The ground color of the back was black with fire-yellow spots in a wide variety of patterns, sometimes in contact with each other, along the entire back. Different sizes of yellow spots were observed in the black background of the extremities in all specimens. Although there were large yellow spots on the dorsal parts of the specimens, there were also small yellow spots, which is a characteristic of the *S. i. orientalis*.

*Salamandra infraimmaculata*, whose taxonomic status and distribution are still the subject of research, is currently divided into three distinct subspecies [1, 7, 10]. *S. i. infraimmaculata* is distributed in parts close to the sea from the Hatay province in Türkiye to Israel; *S. i. orientalis* is distributed in south and southeast Türkiye, and *S. i. semenovi* is distributed in southeastern Türkiye through western Iran and northern Iraq [1, 4, 5, 7, 10] (Figure 1).

Table 1. Morphometric characteristics of the juveniles of *Salamandra infraimmaculata* from Yoncabayarı population.

| Characters | 1st Specimen | 2nd Specimen | 3rd Specimen | 4th Specimen | 5th Specimen |
|---|---|---|---|---|---|
| TBL | 105.18 | 113.52 | 104.24 | 96.18 | 112.32 |
| LCP | 72.46 | 74.27 | 71.63 | 60.02 | 74.03 |
| SVL | 75.57 | 78.43 | 74.70 | 63.14 | 78.10 |
| TL | 29.61 | 35.09 | 29.54 | 33.04 | 34.22 |
| FLL | 21.35 | 22.62 | 20.13 | 18.42 | 22.03 |
| HLL | 24.43 | 26.71 | 23.35 | 21.51 | 26.15 |
| DFHL | 40.27 | 42.11 | 39.78 | 33.77 | 42.02 |
| HL | 20.13 | 21.63 | 19.88 | 16.96 | 21.38 |
| HW | 13.90 | 14.68 | 13.78 | 11.82 | 14.38 |
| PL | 11.73 | 12.12 | 11.38 | 9.79 | 12.01 |
| PW | 4.93 | 5.13 | 4.87 | 4.52 | 5.05 |
| DAP | 9.88 | 10.08 | 9.77 | 8.62 | 10.02 |
| TBL/TL | 3.55 | 3.26 | 3.53 | 2.91 | 3.28 |
| TL/SVL | 0.39 | 0.44 | 0.39 | 0.52 | 0.43 |
| DFHL/SVL | 0.53 | 0.54 | 0.53 | 0.53 | 0.54 |
| PL/HL | 0.58 | 0.56 | 0.57 | 0.58 | 0.56 |
| PW/HW | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 |
| PW/PL | 0.42 | 0.42 | 0.43 | 0.46 | 0.42 |
| HW/HL | 0.69 | 0.68 | 0.69 | 0.70 | 0.67 |

The northernmost locality record (İmranlı district of Sivas province) is provided in this study. The closest locality of the Yoncabayırı-İmranlı site in the literature is the Divriği district of Sivas province [23]. The new locality record shows that the distribution of the species may extend along the branches of the Kızılırmak River. The results of this study are similar to the color-pattern features reported in other studies for *S. i. orientalis*. The color-pattern of individuals belonging to the Yoncabayırı population is the presence of small yellow spots on the dorsal of the salamanders, which corresponds to the general characteristic of the subspecies. On the other hand, the individuals of *S. i. infraimmaculata* mostly have large yellow patches on their dorsal, and the individuals of *S .i. semenovi* have rounded yellow spots on their dorsal [1, 10]. However, it is difficult to reliably distinguish between *S. i. infraimmaculata* and *S. i. orientalis* on morphological grounds [10]. Even within the same subspecies, two distinctly different color morphs can be found, as in Iraq specimens of *S. i. orientalis*. Although there was a color-pattern variation among the specimens of Iraq, Iran, and Türkiye, it was reported that the two Iraqi populations (having different color morphs), not only among each other but also with the neighboring samples from western Iran (southeast of Marivan, near Sarvabad) and eastern Türkiye (Kemaliye district of Erzincan), constituted one unit with almost no genetic distances between the specimens (range from 0.0029 to 0.0064%) after performing a barcoding test based on the fast-evolving mitochondrial COI gene. Slightly more distant from the other samples was the sample from the southeast of Türkiye (Darıpınarı, in Çamlıyayla district of Mersin province) with a genetic divergence of 0.0129-0.0151% [10]. The authors concluded that no specific difference but subspecific rank could be admitted at best.

The present study gives morphometric characters of juvenile individuals which were collected from Yoncabayırı population. However, the reports based on the morphometric measurements of *S. infraimmaculata* in the literature [4, 11, 14, 16] were generally performed the adult individuals except providing data also on juveniles [11, 14, 25, 32]. The mean SVL was 73.9 mm (63.14-78.43 mm) in the juvenile specimens of Yoncabayırı. Similar to our results, the mean SVL was 65.9 mm (53.38-78.42 mm) in two juvenile specimens of *S. i. orientalis* from Mersin province (Mezitli population) [32]. Moreover, the average body length was found to be 45.7 mm (24.2–64.8 mm) in 14 juvenile specimens of *S. i. orientalis* from Bingöl province [25]. On the other hand, it was found to be 59.7 mm (45.6–79.4 mm) in 4 subadult specimens of *S. i. orientalis* from Tunceli province [11].

The mean total body length (TBL) was 106.28 mm (96.18-113.52 mm) in the five juvenile specimens of Yoncabayırı. In addition, the average body length was found to be 81.2 mm (61.5–109.8 mm) in 14 juvenile specimens of *S. i. orientalis* from Bingöl province [25] and it was 96.4 mm (74.5–129.0 mm) in 4 subadult specimens of *S. i. orientalis* from Tunceli province [11].

Except from the mean SVL and mean total length, the ranges of LCP, TL, FLL, HLL, DFHL, HL, HW, PL, PW, DAP values and the ratios of DFHL/SVL/, PL/HL, PW/HW, PW/PL and HW/HL in the juveniles from Sivas (Yoncabayırı) were found to be almost similar to these values and ratios in the subadult specimens of *S. i. orientalis* from Tunceli [11].

The morphometric measurements of the juveniles in the Yoncabayırı population are similar to the specimens of *S. i. orientalis* used in the literature. Because of the color-pattern and morphometric similarities and the geographic distribution, we concluded that the Yoncabayırı (İmranlı, Sivas) specimens are representatives of *S. i. orientalis* subspecies.

However, the color and pattern characteristics alone do not provide adequate distinction for taxonomically assigning individuals of *Salamandra infraimmaculata* [10]. Moreover, the results obtained from morphometric measurements do not exactly coincide with the

geographical distinctions of the subspecies in some cases [33]. Phylogenetic and phylogeographic information acquired through various molecular techniques can be integrated with morphology and distribution data, resulting in a more precise taxonomic classification for the specimens of *S. infraimmaculata* [4].

In this study, we did not investigate the phylogenetic relationships of the individuals of *S. infraimmaculata* from the Yoncabayırı population with other Anatolian populations of the species. The color-pattern features alone are not sufficient to distinguish *Salamandra infraimmaculata* to taxonomically designate individuals [4, 10]. Although there are phylogenetic studies using *Salamandra infraimmaculata* samples from Türkiye, the taxonomic status of the subspecies in Türkiye has not been clearly resolved due to a limited number of samples [7, 10, 21, 22]. The taxonomic placement of the species can be made more reliable with studies containing different phylogenetic and phylogeographic information.

In conclusion, our findings show that the species can be found in different places than its known localities. Comprehensive field observations, that will be carried out along the branches of Kızılırmak River, and Tozanlı and Kelkit streams, especially in the northern districts of Sivas (Zara, Hafik, Gölova, Akıncılar, Suşehri, Koyulhisar, and Doğanşar) and other neighboring provinces (Giresun, Ordu, and Tokat), may reveal the existence of new populations of the species.

## Conflicts of interest

There are no conflicts of interest in this work.

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