



New sites of the endangered Marmaris Salamander, *Lyciasalamandra flavimembris* (Mutz and Steinfartz 1995), (Caudata: Salamandridae) from Muğla, Turkey

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Abstract.— Reported are seven new sites of *Lyciasalamandra flavimembris* found in southeastern Anatolia, Turkey. These data extend the species' distribution range by 45 km in the southwest creating a total species' area of 115 km². We compared morphological and color-pattern characteristics from the new sites with previously published data. The new populations are considered to be *L. f. flavimembris*.

Keywords. Amphibians, conservation, distribution, Lycian salamander, range extension, Anatolia

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Introduction

Lycian salamanders (genus *Lyciasalamandra*) distribution range extends from Greece in the south to the southwest of Turkey and covers some islands including Kastellorizon, Meyisti, Kekova, and Carpathos (Başoğlu et al. 1994; Veith and Steinfartz 2004; Franzen et al. 2008; Sparreboom, 2014). There are seven validated species [*Lyciasalamandra luschani*, *L. atifi*, *L. antalyana*, *L. bil-lae*, *L. fazilae*, *L. flavimembris* in Mediterranean Turkey and *L. helverseni* in Greece] (Sparreboom 2014; Veith et al. 2016). They inhabit Mediterranean-type shrub vegetation and rocky limestone outcrops (Veith and Steinfartz 2004; Sparreboom 2014) and are threatened by habitat loss and fragmentation. Lycian salamanders are endangered species due to their patchy distribution covering a limited surface area (Kaska et al. 2009).

The Marmaris Salamander, *Lyciasalamandra flavimembris* (Mutz and Steinfartz 1995) is listed as endangered by the IUCN Red List given that its habitat covers less than 5,000 km². It is threatened by habitat loss and fragmentation caused by forest fires, and over-collection for scientific purposes (Kaska et al. 2009). A new subspecies *L. f. ilgazi* was recently discovered in Kötekli, province of Muğla based on coloration and pattern characteristics and morphometric measurements (Üzüm et al. 2015). During our research project on conservation

activities of the Marmaris Salamander (in Marmaris and Ula provinces of Muğla, southeastern Anatolia, Turkey) between 2017 and 2018, we detected seven new localities of *Lyciasalamandra flavimembris*.

Methods and Materials

The study site designed 10 km × 10 km Universal Transverse Mercator (UTM) grids for determining actual and possible habitats of the species and all grids were visited three times between February 2017 and March 2018. Visual encounter surveys were used to detect potential sites both during day and night times. During the daytime survey, two observers searched by checking under stones, rocks, outcrops and during the night surveys we observed in all suitable habitats. Global Positioning System (GPS) points were recorded for most localities (Garmin GPS-map 62s). The locations that did not have coordinate data were obtained by using Google Earth vers.7.1.2 (Google, Inc.). All records were geo-referenced into the WGS-84 coordinate system and then checked and visualized with ArcGIS vers.10.1 (ESRI). The records obtained from our field studies and the scientific literature (Baran and Atatür 1986; Başoğlu et al. 1994; Mutz and Steinfartz 1995; Üzüm et al. 2015; Göçmen and Karış 2017) were entered into the UTM grid maps.

Measurements were made in the field and individuals

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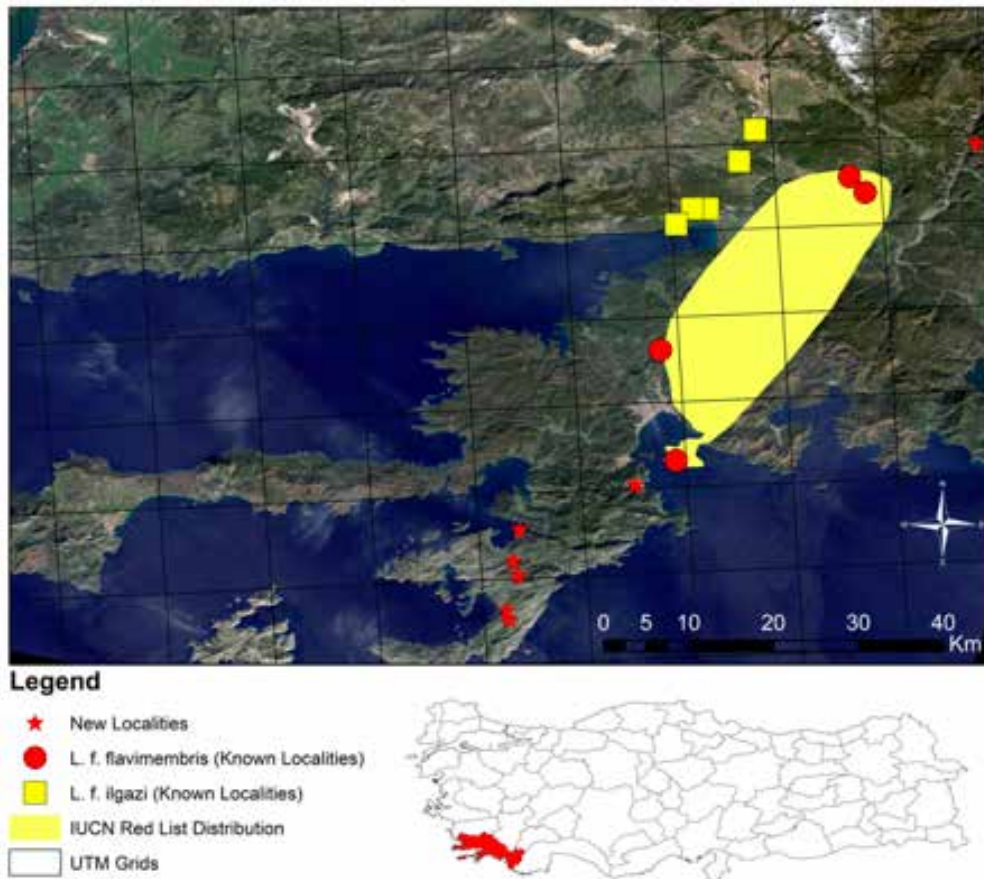


Fig. 1. Distribution of the Marmaris Salamander. Solid red circle denotes known sites of *L. f. flavimembris*, solid red star shows new recorded locations, and yellow squares show known sites of *L. f. ilgazi*. Previously recorded localities of *L. f. flavimembris*, and *L. f. ilgazi* was noted by Baran and Atatür 1986, Başoğlu et al. 1994, Mutz and Steinfartz 1995, Üzümlü et al. 2015, and Göçmen and Karış 2017.

were released in capture location. Used were the following morphometric measurements and ratios: total body length (TBL): tip of snout to tip of tail; rostrum-anus length (RA): tip of snout to posterior end of the cloaca opening; length of trunk (LT): length from gular fold to the anterior edge of cloaca opening; tail length (TL): length from the posterior end of the cloaca opening to the tip of tail; head and body length (HBL): length from snout to the anterior end of the cloaca opening; nostril-eye distance (NED); distance between nostrils (DBN); eye diameter (ED); head length (HL): distance from the snout to the gular fold; head width (HW); parotid length (PL); parotid width (PW); fore limb length (FLL); hind limb length (HLL): distance between fore and hind limbs length (DFHL). Ratios used were: HW/HL, TL/TBL, PW/PL, and NED/HL (e.g., Üzümlü et al. 2015; Göçmen and Karış 2017). Measurements were made using a digital caliper (Mitutoyo) with an accuracy of 0.01 mm. Morphometric measurements were then compared to published data (Mutz and Steinfartz 1995; Üzümlü et al. 2015; Göçmen and Karış 2017). Mean values were provided with their standard deviations using the PAST statistical package (Hammer et al. 2001).

Results and Discussion

During the fieldwork carried out between February 2017 and March 2018 in Marmaris and Ula province of Muğla, discovered were seven new localities for the species (Arıcılar [1], Turunç [2], two km west of Turgut Waterfall [3], Selimiye [4], Söğüt köyü [5], Taşlıca Village [6,7], Fig. 1) for the Marmaris Salamander [between 14 March 2017 and 17 February 2018] (Table 1).

Individuals were observed under rocky limestone outcrops and stones. The newly discovered populations (Fig. 2) extend the species' distribution range 45 km south, creating a new total distribution area of 115 km². The vegetation of the new sites consists of masques scrublands in Selimiye [3], Söğüt köyü [4], and Taşlıca Village and habitats close to pine forests (*Pinus brutia*) Arıcılar [1], Turunç [2], Turgut Waterfall [7] (Fig. 2). There is no difference between previous elevations and the new localities.

We observed 43 individuals (seven juveniles, 17 males, and 19 females) and measured 14 individuals (two juveniles, four males, and eight females). The average measurement for total body length was 111.82

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Table 1. Geographic and some climatic information of the newly discovered sites.

Sites	Latitude	Longitude	Elevation (m)	No. of observed individuals	Temp. (°C)	Hum. (%)
[1] Arıcılar	37°6'	28°35'	650	6 indiv. (1 juveniles, 3 males, 2 females)	22	55
[2] Turunç	36°47'	28°12'	30	14 indiv. (4 juveniles, 6 males, 4 females)	11	85
[3] Turgut Waterfall	36°43'	28°7'	10	4 indiv. (1 male, 3 females)	14	65
[4] Selimiye	36°41' N	28°6' E	60	10 indiv. (1 juvenile, 5 males, 4 females) 6 indiv. measured (1 juvenile, 3 males, 2 females)	13	70
[5] Söğütköy	36°40'	28°6' E	150	5 indiv. (1 juvenile, 4 females) 4 species (1 juvenile, 3 females)	12	72
[6] Taşlıca	36°38'	28°6'	240	2 indiv. (1 male, 1 female)	12	72
[7] Taşlıca	36°37'N	28°6'E	240	2 indiv. (1 male, 1 female)	12	72

mm (range=104–125) for males and 114.65 mm (range 85–143) for females (Table 2). The largest specimen was 150 mm long (Franzen et al. 2008). These lengths were slightly less than the averages found by Mutz and Steinfartz (1995) with 125.9 mm for males and 144.8 mm for females, depending on the location. Üzümlü et al. (2015) described *L. f. ilgazi* and *L. f. flavimembris* subspecies and found the mean of TBL of *L. f. flavimembris* to be 132.49 mm (115.23–147.88) and Göçmen and Karış (2017) found the mean of TBL of *L. f. flavimembris* to be 121.13 mm (102.00–139.00) for males and 113.21 mm (90.00–134.00) for females. Our results are in accordance with the relevant literature.

The color patterns of all new populations showed similarities with the subspecies *L. f. flavimembris*. The dorsum ground color of the individuals is dark purplish-

brown with small irregular scattered silver-white spots. They have a dark head with yellow eyelids and parotids. The venter is separated from the dorsum by an unpigmented discontinuous line along the flanks. The tail and the extremities are yellow to light brown-orange with whitish spots as in mentioned literature (Steinfartz and Mutz 1999; Sparreboom 2014, Fig. 3).

We continue our fieldwork to monitor population trends and habitat preferences of the Marmaris Salamander. This work will be used to promote awareness-raising activities and conservation of the species. Despite these efforts, conservation actions are frequently hampered and delayed by taxonomic instability that makes regional and international cooperation difficult due to misunderstandings concerning the names of priority species (Isaac et al. 2004). The Lycian salamanders have suffered from

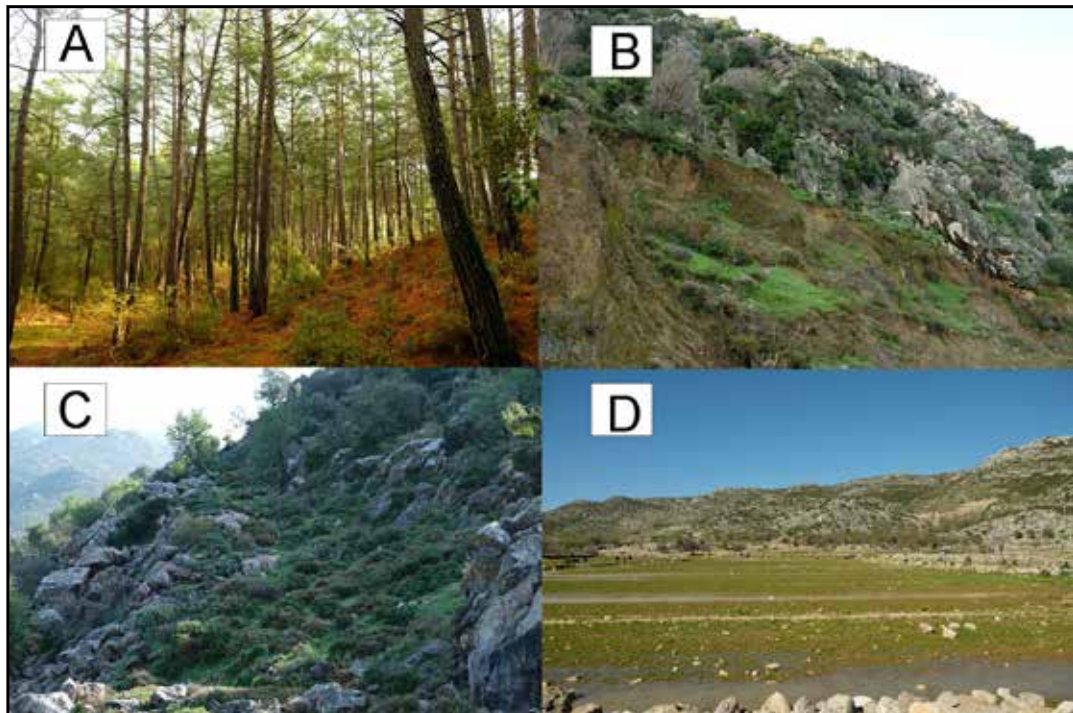


Fig. 2. General view of new site habitats. [A]. Arıcılar, [B,C]. Selimiye [D]. Taşlıca.



Fig. 3. Specimens from new sites. **A.** the right-side female, the middle male, left side juvenile from Arıcılar [1]; **B.** A male from Turunç [2]; **C.** A male from Selimiye [4] **D.** A juvenile from Söğütköy [5].

this situation with three new recognized species (*L. irfani*, *L. arikani*, and *L. yehudahi*) (Göçmen et al. 2011; Göçmen and Akman 2012) being changed to subspecies of *L. billae* (Veith et al. 2016) over the last six years. The species has also suffered due to scientific collection for taxonomic studies and the pet trade, reducing population sizes (UNEP-WCMC 2008). We hope that future faunal and taxonomic studies on Lycian salamanders will be designed to involve low/no specimen collections. All

Lycian salamanders are listed IUCN Red List due to its extent of occurrence less than 5,000 km², limited distribution, and declining habitat loss and quality. The distribution area of Marmaris salamanders with new localities are about 100 km². We also observed tourist activities, urbanization, pet trade, and environmental pollution which are further threats to populations. Conservation and ecological studies are urgently necessary to help sustain the species.

Table 2. Summary of body measurements and related statistics (mm). [*n* = the number of specimens, SE = standard error of mean, Min.–Max. = extreme values, SD = standard deviation, and other character abbreviations are given in the Materials and Methods section]

Characters	Juveniles (<i>n</i> = 2)						Males (<i>n</i> = 4)						Females (<i>n</i> = 8)					
	<i>n</i>	Mean	SE	Min	Max	SD	<i>n</i>	Mean	SE	Min	Max	SD	<i>n</i>	Mean	SE	Min	Max	SD
HL	2	9.5	3.50	6.0	13.0	4.95	4	13.0	1.47	10.1	17.0	2.95	8	12.8	1.00	7.7	16.0	2.82
RA	2	40.4	1.90	38.5	42.3	2.69	4	61.7	2.00	57.5	66.0	4.00	8	61.2	3.37	47.0	76.0	9.54
TL	2	30.5	3.00	27.5	33.5	4.24	4	49.3	2.16	44.7	54.1	4.33	8	53.0	3.14	35.6	67.0	8.89
LT	2	20.6	2.60	18.0	23.2	3.68	4	35.3	1.84	30.6	39.6	3.68	8	36.0	2.19	26.6	43.0	6.20
HW	2	5.5	4.55	0.9	10.0	6.43	4	13.7	0.51	12.2	14.4	1.01	8	11.5	0.58	10.1	14.9	1.64
PL	2	5.0	1.05	3.9	6.0	1.48	4	8.1	0.46	7.0	9.0	.92	8	7.0	0.72	3.4	9.2	2.03
PW	2	4.0	2.00	2.0	6.0	2.83	4	3.8	0.68	2.5	5.0	1.36	8	2.8	0.69	0.2	7.0	1.96
NED	2	3.0	0.00	3	3	0.00	4	3.0	0.41	2	4	0.82	8	3.5	0.48	1	6	1.37
DBN	2	2.7	2.31	0.4	5.0	3.27	4	2.3	0.95	0.6	5.0	1.89	8	3.4	0.70	0.4	6.0	1.97
ED	2	4.5	1.50	3	6	2.12	4	3.9	1.02	1	6	2.04	8	3.5	0.27	2	4	0.75
FLL	2	12.5	0.50	12	13	0.71	4	20.8	1.65	17	25	3.30	8	19.4	1.66	13	28	4.69
HLL	2	15.0	1.00	14	16	1.41	4	27.3	0.48	26	28	0.96	8	20.7	1.93	12	29	5.47
TBL	2	69.0	3.00	66.0	72.0	4.24	4	111.8	4.97	104.0	125.0	9.94	8	114.7	6.72	85.0	143.0	19.02

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