

Comparative study on the endangered Marmaris Lycian salamander populations, *Lyciasalamandra flavimembris* (Mutz & Steinfartz, 1995) (Caudata: Salamandridae), with the description of several new localities

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Abstract. We report on several new populations of the Marmaris salamander, *Lyciasalamandra flavimembris*, discovered from Muğla province, based on our scientific fieldwork in February-April 2015. We encountered five new localities for the species, one of them belongs to *L. f. flavimembris*, and four localities for *L. l. ilgazi*, respectively. In order to determine the differentiation between these two subspecies, all populations were examined morphologically and compared in detail. We studied a total 55 individuals (*L. f. flavimembris*: 8♂♂, 14♀♀, 4 juv.; and *L. l. ilgazi*: 6♂♂, 19♀♀, 4 juv.) based on our material collected in the field. Furthermore, we compared morphometric results and colour-pattern characteristics between the two subspecies. With the new records, the number of known localities for the species is increased from four to nine.

Key words: Marmaris salamander, *Lyciasalamandra flavimembris*, morphology, distribution, Turkey.

Introduction

The first Lycian salamander specimens were found by Prof. Luschan from the village Dodurga, Eşen, Fethiye-Muğla province in 1884. The first Lycian salamander species was described with these specimens in 1891 by Steindachner as *Molge luschnani*. This terrestrial salamander species was transferred to the genus *Salamandra* in 1892 by Boulenger.

On the other hand, a semi-aquatic salamander species was described by Waga in 1876 from Caucasus and northeastern Anatolia as *Exaeretus caucasica*. Wolterstorff (1925) indicated that the males of these two species (*Exaeretus caucasica* and *Salamandra luschnani*) shared similar morphological characteristics (dorsal protuberance at base of the tail) that was not found in any other salamander species, and consequently he described the genus *Mertensiella* for these two species and accepted them as type species for the genus *Mertensiella*. Özeti (1967) suggested that, based on comparative osteological studies, the genus *Mertensiella* should be accepted as subgenus of *Salamandra* (*Salamandra (Mertensiella) luschnani*).

The first Marmaris salamander specimens were found by Baran & Atatür (1986) from Marmaris and Çiçekli village-Ula, Muğla province, but diagnosed as *Mertensiella luschnani helverseni* which was described by Pieper (1963) from Karpathos island. Mutz & Steinfartz (1995) showed the obvious morphological differences

and allopatry between the Anatolian and Karpathos specimens and consequently described the Anatolian "*helverseni*" populations as *Mertensiella luschnani flavimembris* and stated that 6 km north of Marmaris locality as terra typica.

Franzen & Steinfartz (1999) and Steinfartz & Mutz (1999) stated that the Lycian salamanders can be distinguished from all other genera of salamanders within Salamandridae by an additional phalanx at the first digits and toes. In the light of recent molecular studies, the taxonomy of these salamanders has been reorganized and the genus "*Lyciasalamandra*" was described by Veith & Steinfartz (2004). In addition, all species of the genus *Lyciasalamandra*, except the *Lyciasalamandra luschnani* subspecies (*L. l. luschnani*, *L. l. basoglu* and *L. l. finikensis*), were raised to species level by detailed and comprehensive studies (Veith et al. 1998, Weisrock et al. 2001, Veith & Steinfartz 2004). The Marmaris Salamander is listed as endangered by the IUCN. Üzüm et al. (2015) described a new subspecies of Marmaris salamander as *Lyciasalamandra flavimembris ilgazi* from Kötekli, Muğla province.

At present, the genus *Lyciasalamandra* contains a total of 15 taxa within an area of approximately 385 km along the Mediterranean coast of Turkey between Gürçam, Gazipaşa, Antalya and Marmaris, Muğla provinces, and some nearby offshore islands (Veith et al. 2001, Akman et al. 2011, Göçmen et al. 2013). On the other hand, *Lyciasalamandra flavimembris* has only a 40 km

distribution range (north-south direction) from Boğaz Island to the Kötekli, Muğla province with its altitude range between 80-650 m asl. *Lyciasalamandra f. flavimembris* has approximately 35 km distribution range from Boğaz Island to Çiçekli-Ula, Muğla province between the altitude of 80-620 m asl, while ssp. *ilgazi* is only known from the type locality (Kötekli) at 650 m asl (Baran & Atatürk 1986, Başoğlu et al. 1994, Veith et al. 2001, Üzüm et al. 2015).

To clarify the taxonomic status and compare the populations of nominate race and ssp. *ilgazi*, we conducted scientific fieldworks in February 2011 and 2015, April 2015. We found a total 55 individuals (*L. f. flavimembris*: 8♂, 14♀, 4 juv.; and *L. l. ilgazi*: 6♂, 19♀, 4 juv.) which belong to nine populations. One locality for *L. f. flavimembris* and four *L. l. ilgazi* localities are newly discovered. Furthermore, we compared both subspecies.

Materials and Methods

The *Lyciasalamandra flavimembris* specimens for the morphological comparisons consist of 26 (8♂, 14♀, 4 juv.) *L. f. flavimembris* specimens collected from four localities in February 2011, 2015 and April 2015, and of 29 (6♂, 19♀, 4 juv.) *L. l. ilgazi* specimens collected from five localities in February 2015; all specimens are deposited in the Zoology Museum of Adiyaman University (ZMADYU). Studied material and population descriptions are listed in Table 1.

The current distribution map of the *Lyciasalamandra flavimembris* with newly discovered localities is given in Figure 1. Although the geographical coordinates of the caught specimens were computed with a Magellan model XL GPS, we do not publish exact locality (seconds of the coordinates) to reduce motivation for illegal collecting.

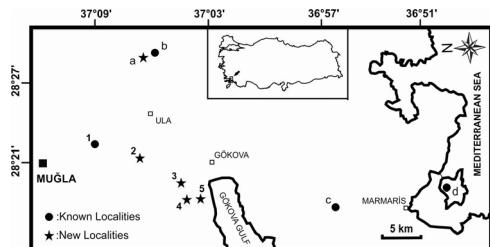


Figure 1. Current distribution of the *Lyciasalamandra flavimembris*. Letters indicate ssp. *flavimembris*, numbers indicate ssp. *ilgazi*, and compass indicates North direction. For locality details, letters and numbers see Table 1.

Collected specimens were kept alive for a period in properly prepared aqua-terrariums for colouration analysis, photography and behaviour observations. Photographs are taken with Olympus C-5060WZ and Nikon D-5000 digital cameras.

Following colouration analysis and behavioural observations, the specimens were initially etherized, then injected with 96% ethanol and stored in glass jars with 96% ethanol to facilitate future DNA analyses. All collected specimens were deposited in the Zoology Museum of Adiyaman University (ZMADYU).

Table 1. Voucher numbers and locality descriptions of *L. f. flavimembris* and *L. f. ilgazi* with details of new localities for both subspecies.

Taxa	Voucher Number (ZMADYU)	Localities	Altitude (m asl)	Latitude (DM)	Longitude (DM)	Collection date, number of specimens	Temperature (°C)
<i>L. f. flavimembris</i>	2015/124:1	İncir Mevkii, Armutçuk/Ula (a)	600	37°06'	28°28'	09.04.2015, 1 juv.	10
	2015/125:1-7	Çiçekli Village/Ula (b)	615	37°05'	28°29'	23.02.2015, 7 spec. (2♂, 4♀, 1 juv.)	9
	2011/88: 1-5	6 km North of Marmaris (c)	90	36°55'	28°16'	14.02.2011, 5 spec. (1♂, 2♀, 2 juv.)	10
	2015/126:1-2	6 km North of Marmaris (c)	90	36°55'	28°16'	28.02.2015, 2 spec. (1♂, 1♀)	11
	2015/127:1-11	Boğaz Adası (d)	100	36°48'	28°17'	24.02.2015, 11 spec. (4♂, 7♀)	10
<i>L. f. ilgazi</i>	2015/128:1-6	Kötekli (1)	660	37°09'	28°22'	14.02.2015, 6 spec. (1♂, 2♀, 3 juv.)	8
	2015/129:1-10	Thera Antique City, near Doğan (2)	700	37°07'	28°21'	24.02.2015, 10 spec. (2♂, 7♀, 1 juv.)	7
	2015/130:1	Sakarteppe, near Kızılıağac/Ula (3)	890	37°04'	28°19'	28.02.2015, 1♀	9
	2015/131:1-2	Kuyucak (4)	750	37°04'	28°18'	28.02.2015, 2 spec. (1♂, 1♀)	8
	2015/132:1-10	near Akyaka, Ula (5)	390	37°03'	28°17'	24.02.2015, 10 spec. (2♂, 8♀)	6

After having proven normal distribution of measurements we applied Student's *t*-tests to show potential sexual dimorphisms between subspecies (populations were pooled). For mensural (metric) character comparison we used also sum adults (higher value of 90 mm by Total Body Length) to avoid effects of allometry.

Metric characters were measured with a Mitutoyo digital caliper to the nearest 0.02 mm, except Total Body Length, Rostrum-Anus Length and Tail Length, which were measured by a millimetric ruler. Summarized statistics were conducted with "SPSS 15.0 for Windows". Furthermore, to control the test results of raw metric characters they were again tested with a Student's *t*-test, but taking indexed values of PERCRA (percent of rostrum-anus length; (each metric character / RA) × 100), according to Werner (1971). The evaluation of all statistical analyses were based on the statistical significance level of " $p \leq 0.05$ ".

Mensural (metric) characters

Total Body Length - the length of the whole body including the tail (TBL), Rostrum-Anus Length - length from the snout to the anterior pole of the cloacal opening (RA), Length of Trunk - length from gular fold to the anterior edge of cloacal opening (LT), Tail Length (TL), Nostril-Eye Distance (NED), Distance Between Nostrils (DBN), Eye Diameter (ED), Head Length - distance from the snout to the posterior edge of parotoid glands (HL), Head Width (HW), Parotoid Length (PL), Parotoid Width (PW), Fore Limb Length (FLL), Hind Limb Length (HLL), Distance between Fore- and Hind Limbs (DFHL), Height of Dorsal Protuberance at the Base of Tail (HDPBT) - only in males.

Computed characters (ratios)

Ratios of the characters HW/HL, TL/TBL, PW/PL, NED/HL and all characters/RA × 100 (PERCRA) were also computed and compared with Student's *t*-test.

The present study was carried out according to the Animal Experiments Ethical Committee of Ege University ((permit) #: 2011-091) and approved by the Republic of Turkey Ministry of Forestry and Water Affairs, General Directorate of Nature Protection and Natural Parks (date: 20 March 2014, ((permit) #: 72784983-488.04-62406).

Results and Discussion

For presentation of the measurements, adults (14 ♀♀, 8 ♂♂) and juveniles (4) of *L. f. flavimembris*, also adults (19 ♀♀, 6 ♂♂) and juveniles (4) of *L. f. ilgazi* are grouped and descriptive statistics are given separately. Since Student's *t*-test indicated significant differences between the sexes, morphological characters are presented first separated by sex followed by a population comparison with sexes combined (juveniles excluded). Summarized statistics of the both

subspecies by the raw data, ratios and PERCRA indices are given in Table 2 and Table 3. The abbreviations are given in the Material and Method section. We found significant differences between the subspecies by the Student's *t*-test.

According to Student's *t*-tests (see Table 4) we determined statistically significant ($p \leq 0.05$) differences between males of the two subspecies in terms of characters from the raw data (TBL, RA, LT, HW, HL, PL, PW, FLL, HLL), the ratios (HW/HL, TL/TBL, PW/PL), and the PERCRA index values (LT, DBN, ED, HL). When comparing females, significant differences ($p \leq 0.05$) were found for some raw data (NED, PW) and PERCRA index values (NED, HW, PL, PW, FLL). When the juveniles are compared for both of two subspecies, we detected significantly different ($p \leq 0.05$) characters by the raw data (PL, PW), by ratios (HW/HL, TL/TBL, PW/PL, NED/HL), and by some PERCRA index values (PL, PW, DFHL). Most importantly, adult specimens are combined (males+females) of both populations for two subspecies separately and compared by Student's *t*-test. As a result, we found statistically significant differences ($p \leq 0.05$) in some characters between the adult specimens of both subspecies by the raw data (NED, HL, PW, PL) and by the PERCRA index values (TL, NED, ED, HW, PL, PW, FLL, HLL) (Table 4). *Lyciasalamandra flavimembris ilgazi* specimens are relatively bigger than nominotypic specimens, with their total length reaching 15 cm.

Colour-pattern characteristics of nominotypic subspecies of Marmaris salamander, *Lyciasalamandra flavimembris flavimembris* populations, agree with the description of Mutz & Steinfartz (1995). Newly discovered İncir Mevkii, Armutçuk village-Ula (similar with Çiçekli - Fig. not given) and, Çiçekli village-Ula (Fig. 2), 6 km north of Marmaris (type locality) (Fig. 3), Boğaz Island (Fig. 4) populations are included to nominate subspecies (for map Fig. 1, details Table 1).

When analyzing the colour-pattern characters of *Lyciasalamandra flavimembris ilgazi* populations, we agree with the description of Üzüm et al. (2015) in terms of purplish dark brown ground colour and a relatively lighter colouration on tail and extremities, with small irregular scattered yellowish spots. However, many specimens of the nominotypic subspecies (*L. f. flavimembris*) - especially at the type locality - also have the abovementioned ground colour-pattern characteristics on dorsum, but absence on the

Table 2. Summarized statistics of some mensural characters (in mm) and ratios of the *L. f. flavimembris* populations. 1: Raw data; 2: PERCRA index; N: number of specimens; SD: Standard deviation; SE: Standard error of mean. The other abbreviations of characters are given in Materials and Methods.

Characters	♂♂						♀♀						
	N	Min.	Max.	Mean	SD	SE	N	Min.	Max.	Mean	SD	SE	
TBL	1	8	102.00	139.00	121.13	11.04	3.903	14	90.00	134.00	113.21	16.30	4.355
	2	8	184.38	196.15	190.82	3.99	1.411	14	174.14	194.20	187.58	6.51	1.741
RA	1	8	52.00	72.00	63.50	5.86	2.070	14	48.00	69.00	60.29	7.82	2.090
LT	1	8	37.28	54.35	47.54	5.01	1.773	14	34.22	51.93	44.66	6.30	1.683
	2	8	71.69	76.05	74.78	1.43	0.504	14	71.29	75.74	73.98	1.18	0.315
TL	1	8	45.00	67.00	57.25	6.84	2.418	14	42.00	65.00	53.50	8.61	2.301
	2	8	84.38	96.92	90.01	4.21	1.489	14	78.18	94.20	88.52	5.23	1.399
NED	1	8	2.11	3.41	2.91	0.39	0.138	14	1.88	3.31	2.62	0.42	0.113
	2	8	4.06	5.13	4.58	0.38	0.133	14	3.68	4.89	4.35	0.34	0.090
DBN	1	8	3.96	5.43	4.80	0.49	0.173	14	3.75	5.35	4.59	0.49	0.131
	2	8	7.23	8.48	7.56	0.39	0.138	14	6.63	9.00	7.66	0.61	0.163
ED	1	8	4.04	5.53	4.74	0.49	0.172	14	3.81	5.33	4.50	0.42	0.113
	2	8	6.92	8.02	7.48	0.41	0.146	14	6.52	8.31	7.51	0.57	0.153
HL	1	8	14.72	17.65	15.96	1.02	0.361	14	13.18	17.89	15.62	1.60	0.428
	2	8	23.95	28.31	25.22	1.43	0.504	14	24.26	28.71	26.02	1.18	0.315
HW	1	8	9.22	12.36	10.82	0.92	0.325	14	8.52	12.17	10.45	1.14	0.304
	2	8	16.40	17.73	17.06	0.44	0.156	14	16.14	19.77	17.40	0.91	0.242
PL	1	8	6.69	9.11	7.59	0.93	0.329	14	5.96	9.16	7.32	1.11	0.297
	2	8	10.45	13.40	11.96	1.05	0.371	14	10.61	13.28	12.13	0.71	0.191
PW	1	8	1.57	3.08	2.19	0.47	0.165	14	1.41	2.39	1.96	0.29	0.078
	2	8	2.45	4.81	3.45	0.72	0.253	14	2.14	3.67	3.27	0.40	0.107
FLL	1	8	18.76	21.91	20.39	1.22	0.431	14	15.15	21.36	19.34	1.95	0.522
	2	8	29.29	37.06	32.26	2.38	0.842	14	29.86	35.50	32.22	1.76	0.472
HLL	1	8	20.52	25.35	22.77	1.59	0.564	14	17.70	23.70	21.45	1.99	0.531
	2	8	34.20	40.50	35.98	2.07	0.731	14	32.68	40.05	35.77	2.07	0.553
DFHL	1	8	32.01	38.44	34.42	2.09	0.738	14	24.29	40.56	33.64	5.19	1.388
	2	8	49.61	67.06	54.55	5.54	1.958	14	47.63	69.83	55.81	5.29	1.415
HDPBT	1	8	1.11	2.19	1.51	0.36	0.127						
	2	8	1.76	3.37	2.37	0.49	0.172						
HW/HL	1	8	0.51	0.54	0.52	0.01	0.004	14	0.39	0.75	0.58	0.13	0.034
TL/TBL	1	8	1.41	1.88	1.66	0.17	0.059	14	0.46	2.10	1.46	0.54	0.145
PW/PL	1	8	1.12	1.31	1.20	0.06	0.021	14	0.22	1.27	0.98	0.40	0.107
NED/HL	1	8	0.18	0.21	0.19	0.01	0.003	14	0.14	0.25	0.19	0.04	0.010

Characters	Juveniles						Sum Adults (♂♂+♀♀)						
	N	Min.	Max.	Mean	SD	SE	N	Min.	Max.	Mean	SD	SE	
TBL	1	8	69.00	86.00	75.75	7.41	3.705	22	90.00	139.00	116.09	14.84	3.164
	2	8	176.92	189.47	182.58	5.24	2.619	22	174.14	196.15	188.76	5.84	1.245
RA	1	8	38.00	47.00	41.50	4.04	2.021	22	48.00	72.00	61.45	7.20	1.534
LT	1	8	26.35	34.90	30.00	3.75	1.873	22	34.22	54.35	45.71	5.91	1.260
	2	8	69.34	74.26	72.15	2.15	1.075	22	71.29	76.05	74.27	1.30	0.277
TL	1	8	27.00	39.00	32.50	5.20	2.598	22	42.00	67.00	54.86	8.06	1.717
	2	8	69.23	82.98	78.03	6.09	3.045	22	78.18	96.92	89.06	4.84	1.032
NED	1	8	1.33	2.16	1.74	0.38	0.190	22	1.88	3.41	2.73	0.43	0.091
	2	8	3.50	4.62	4.15	0.55	0.275	22	3.68	5.13	4.43	0.36	0.077
DBN	1	8	3.29	3.72	3.50	0.18	0.088	22	3.75	5.43	4.67	0.49	0.104
	2	8	7.91	9.18	8.47	0.53	0.264	22	6.63	9.00	7.62	0.53	0.114
ED	1	8	3.27	3.86	3.56	0.24	0.121	22	3.81	5.53	4.59	0.45	0.097
	2	8	8.21	9.34	8.61	0.50	0.251	22	6.52	8.31	7.50	0.51	0.108
HL	1	8	11.04	12.10	11.50	0.48	0.238	22	13.18	17.89	15.75	1.40	0.298
	2	8	25.74	30.66	27.85	2.15	1.075	22	23.95	28.71	25.73	1.30	0.277
HW	1	8	7.40	8.87	8.13	0.60	0.301	22	8.52	12.36	10.59	1.06	0.225
	2	8	18.87	21.50	19.65	1.24	0.621	22	16.14	19.77	17.27	0.77	0.165

Table 2. (continued)

Characters	Juveniles						Sum Adults ($\delta\delta + \varphi\varphi$)						
	N	Min.	Max.	Mean	SD	SE	N	Min.	Max.	Mean	SD	SE	
PL	1	8	4.81	5.05	4.93	0.10	0.049	22	5.96	9.16	7.42	1.04	0.221
	2	8	10.49	12.95	11.95	1.05	0.523	22	10.45	13.40	12.07	0.83	0.177
PW	1	8	1.35	1.75	1.57	0.16	0.082	22	1.41	3.08	2.04	0.37	0.079
	2	8	2.87	4.49	3.82	0.70	0.351	22	2.14	4.81	3.33	0.53	0.113
FLL	1	8	13.54	14.73	14.27	0.53	0.263	22	15.15	21.91	19.72	1.77	0.377
	2	8	31.34	37.50	34.60	3.27	1.635	22	29.29	37.06	32.24	1.95	0.417
HLL	1	8	15.35	17.03	15.94	0.76	0.380	22	17.70	25.35	21.93	1.93	0.411
	2	8	36.23	40.64	38.55	2.29	1.146	22	32.68	40.50	35.85	2.02	0.431
DFHL	1	8	21.81	26.24	23.17	2.07	1.037	22	24.29	40.56	33.92	4.28	0.912
	2	8	53.83	57.39	55.88	1.51	0.754	22	47.63	69.83	55.35	5.29	1.127
HDPBT	1	8						8	1.11	2.19	1.51	0.36	0.127
	2	8						8	1.76	3.37	2.37	0.49	0.172
HW/HL	1	8	0.67	0.73	0.71	0.03	0.014	22	0.39	0.75	0.56	0.10	0.022
TL/TBL	1	8	0.39	0.45	0.43	0.03	0.014	22	0.46	2.10	1.53	0.45	0.096
PW/PL	1	8	0.27	0.36	0.32	0.04	0.019	22	0.22	1.31	1.06	0.34	0.071
NED/HL	1	8	0.11	0.18	0.15	0.03	0.015	22	0.14	0.25	0.19	0.03	0.006

Table 3. Summarized statistics of some mensural characters (in mm) and ratios, of the *L. f. ilgazi* populations. 1: Raw data; 2: PERCRA index; N: number of specimens; SD: Standard deviation; SE: Standard error of mean. The other abbreviations of characters are given in Materials and Methods.

Characters	$\delta\delta$						$\varphi\varphi$						
	N	Min.	Max.	Mean	SD	SE	N	Min.	Max.	Mean	SD	SE	
TBL	1	6	127.00	142.00	134.33	5.92	2.418	19	90.00	149.00	116.79	20.25	4.645
	2	6	179.17	191.89	186.96	5.31	2.169	19	171.23	193.51	185.62	5.20	1.194
RA	1	6	70.00	74.00	71.83	1.60	0.654	19	49.00	77.00	62.84	10.24	2.350
	2	6	52.89	56.65	54.67	1.58	0.646	19	35.69	57.53	46.62	7.87	1.806
LT	1	6	75.25	76.86	76.10	0.69	0.283	19	71.61	76.55	74.11	1.17	0.269
	2	6	57.00	68.00	62.50	4.68	1.910	19	40.00	72.00	53.95	10.32	2.368
TL	1	6	79.17	91.89	86.96	5.31	2.169	19	71.23	93.51	85.62	5.20	1.194
	2	6	2.77	3.29	3.11	0.20	0.080	19	2.25	3.84	2.99	0.49	0.112
NED	1	6	3.96	4.70	4.33	0.27	0.111	19	4.29	5.41	4.77	0.36	0.083
	2	6	4.67	5.19	4.99	0.18	0.075	19	3.59	5.81	4.65	0.60	0.139
DBN	1	6	6.49	7.21	6.95	0.31	0.127	19	6.01	8.56	7.45	0.62	0.143
	2	6	4.53	5.37	4.90	0.34	0.139	19	3.61	5.39	4.49	0.62	0.142
ED	1	6	6.47	7.36	6.81	0.34	0.138	19	6.20	8.45	7.18	0.56	0.128
	2	6	16.66	17.82	17.16	0.39	0.160	19	12.68	20.66	16.23	2.50	0.573
HL	1	6	23.14	24.75	23.90	0.69	0.283	19	23.45	28.39	25.89	1.17	0.269
	2	6	11.61	12.66	12.16	0.40	0.163	19	9.08	13.51	11.30	1.46	0.335
HW	1	6	16.59	17.34	16.92	0.33	0.134	19	16.75	19.86	18.09	0.83	0.190
	2	6	7.85	9.44	8.86	0.69	0.283	19	6.23	10.87	8.05	1.42	0.326
PL	1	6	10.90	13.33	12.34	1.07	0.436	19	10.82	14.49	12.83	0.88	0.201
	2	6	2.11	3.01	2.73	0.34	0.139	19	1.81	3.12	2.41	0.42	0.097
PW	1	6	2.85	4.26	3.81	0.53	0.216	19	3.24	4.46	3.84	0.36	0.083
	2	6	20.51	23.46	21.77	0.98	0.399	19	14.97	24.69	19.36	3.02	0.694
FLL	1	6	27.72	32.14	30.32	1.51	0.616	19	27.35	32.93	30.88	1.24	0.283
	2	6	23.78	25.75	25.01	0.66	0.271	19	16.78	27.41	21.80	3.49	0.800
HLL	1	6	33.97	35.79	34.81	0.68	0.278	19	33.23	37.64	34.71	1.05	0.241
	2	6	33.69	41.12	36.35	2.69	1.096	19	25.62	43.27	33.87	5.78	1.325
DFHL	1	6	1.53	2.01	1.78	0.19	0.079	19	51.18	58.17	53.88	1.98	0.454
	2	6	2.13	2.75	2.48	0.25	0.101						
HW/HL	1	6	0.67	0.75	0.71	0.03	0.012	19	0.52	0.58	0.54	0.02	0.004
TL/TBL	1	6	0.44	0.48	0.46	0.02	0.006	19	1.21	1.80	1.57	0.18	0.042
PW/PL	1	6	0.22	0.38	0.31	0.05	0.021	19	0.94	1.26	1.16	0.07	0.016
NED/HL	1	6	0.16	0.19	0.18	0.01	0.004	19	0.18	0.20	0.19	0.01	0.002

Table 3. (continued)

Characters	Juveniles						Sum Adults (♂♂+♀♀)						
	N	Min.	Max.	Mean	SD	SE	N	Min.	Max.	Mean	SD	SE	
TBL	1	4	70.00	81.00	74.75	5.19	2.594	25	90.00	149.00	121.00	19.32	3.864
	2	4	172.34	182.05	177.22	4.37	2.184	25	171.23	193.51	185.94	5.15	1.030
RA	1	4	39.00	47.00	42.25	3.95	1.974	25	49.00	77.00	65.00	9.73	1.945
LT	1	4	26.84	34.37	29.88	3.54	1.771	25	35.69	57.53	48.55	7.70	1.540
	2	4	68.82	73.13	70.61	1.83	0.915	25	71.61	76.86	74.59	1.37	0.275
TL	1	4	31.00	34.00	32.50	1.29	0.645	25	40.00	72.00	56.00	9.92	1.983
	2	4	72.34	82.05	77.22	4.37	2.184	25	71.23	93.51	85.94	5.15	1.030
NED	1	4	1.72	2.31	2.09	0.28	0.141	25	2.25	3.84	3.02	0.43	0.087
	2	4	4.41	5.92	4.97	0.67	0.336	25	3.96	5.41	4.66	0.39	0.078
DBN	1	4	3.23	3.79	3.47	0.28	0.140	25	3.59	5.81	4.73	0.55	0.110
	2	4	8.06	8.31	8.22	0.11	0.055	25	6.01	8.56	7.33	0.60	0.120
ED	1	4	3.35	3.91	3.65	0.28	0.138	25	3.61	5.39	4.58	0.59	0.117
	2	4	8.19	8.90	8.64	0.33	0.166	25	6.20	8.45	7.09	0.53	0.106
HL	1	4	11.74	12.94	12.37	0.53	0.264	25	12.68	20.66	16.45	2.21	0.442
	2	4	26.87	31.18	29.39	1.83	0.915	25	23.14	28.39	25.41	1.37	0.275
HW	1	4	8.11	9.02	8.60	0.38	0.188	25	9.08	13.51	11.51	1.33	0.266
	2	4	19.19	22.00	20.43	1.24	0.619	25	16.59	19.86	17.81	0.89	0.178
PL	1	4	5.53	6.45	6.04	0.38	0.192	25	6.23	10.87	8.25	1.32	0.263
	2	4	12.81	15.77	14.35	1.23	0.613	25	10.82	14.49	12.71	0.93	0.185
PW	1	4	1.72	2.53	2.09	0.33	0.167	25	1.81	3.12	2.49	0.42	0.084
	2	4	4.41	5.38	4.92	0.44	0.221	25	2.85	4.46	3.83	0.40	0.079
FLL	1	4	12.63	14.71	13.35	0.93	0.467	25	14.97	24.69	19.94	2.86	0.571
	2	4	29.27	33.79	31.69	1.91	0.953	25	27.35	32.93	30.74	1.30	0.259
HLL	1	4	14.14	15.81	15.14	0.71	0.354	25	16.78	27.41	22.57	3.34	0.668
	2	4	33.64	39.15	35.97	2.38	1.188	25	33.23	37.64	34.74	0.96	0.193
DFHL	1	4	19.11	24.51	21.80	2.51	1.255	25	25.62	43.27	34.47	5.26	1.052
	2	4	49.00	52.84	51.52	1.71	0.856	25	46.79	58.17	53.09	2.66	0.532
HDPBT	1							6	1.53	2.01	1.78	0.19	0.079
	2							6	2.13	2.75	2.48	0.25	0.101
HW/HL	1	4	0.55	0.58	0.56	0.01	0.007	25	0.52	0.75	0.58	0.08	0.015
TL/TBL	1	4	1.40	1.88	1.68	0.21	0.103	25	0.44	1.80	1.31	0.51	0.102
PW/PL	1	4	0.99	1.17	1.10	0.09	0.043	25	0.22	1.26	0.95	0.37	0.075
NED/HL	1	4	0.20	0.22	0.20	0.01	0.005	25	0.16	0.20	0.19	0.01	0.002

anterior part of head, the parotoids, the tail and the extremities. Upper eyelids are blackish in ssp. *ilgazi* while nominate ssp. specimens having mainly yellowish upper eyelids. Yellowish spots are bigger as blotches on the anterior part of both flanks in ssp. *ilgazi*, while nominotypic specimens have smaller and more abundant yellowish flecks on lateral side of the trunk; however, these flecks are discontinuous and never constitute a lateral band. Some ssp. *ilgazi* specimens, especially from the near Akyaka population, have an almost patternless dorsum. Previously known type locality (Kötekli) (Fig. 5) and newly discovered Thera antique city-Doğan (Fig. 6), Sakartepe-Kızılıağac/Ula (similar with Akyaka - Fig. not given), Kuyucak (similar with Akyaka - Fig. not given), near Akyaka, Ula (Fig. 7) populations are included to ssp. *ilgazi* (for map Fig. 1, details Table 1). According to these results, ssp. *ilgazi* is similar to *Lyciasalamandra atifi* in term of dark ground

colouration.

We conducted many field trips during the active season of Lycian salamanders (February 2011 and 2015, April 2015) to different suitable habitats in Muğla province. We found in total nine populations of Marmaris salamander, four of them belong to the nominate subspecies and five populations belong to ssp. *ilgazi*. All specimens were found under stones on rainy days. Temperatures were between 6-11 °C. We restated the altitude range of ssp. *ilgazi* as 390-890 m asl. Up to now, Sakartepe, near Kızılıağac/Ula, is the highest known locality (890 m) both for ssp. *ilgazi* and the species.

General flora was characterized by forested areas with *Pinus brutia* and covered with typical mediterranean maquis. Also, the karstic limestones were covered with green mosses, *Brachythecium* sp. (Bryophyte).

We also would like to point out that all

Table 4. Comparisons of mensural characters between *L. f. flavimembris* and *L. f. ilgazi* populations with *p*-values (significance of Student's *t*-test). Significantly different values from each other ($p \leq 0.05$) are boldfaced. 1: According to the values in raw data; 2: According to the values in PERCRA index, *: Adult males and females. The other abbreviations of the characters are given in Materials and Methods.

Characters	Males	Females	Juveniles	*Sum Adults
TBL	1 0.015	0.579	0.832	0.331
	2 0.170	0.362	0.167	0.088
RA	1 0.005	0.422	0.800	0.159
	2 0.043	0.751	0.317	0.416
LT	1 0.114	0.893	1.000	0.667
	2 0.275	0.127	0.837	0.040
NED	1 0.253	0.029	0.184	0.027
	2 0.169	0.002	0.110	0.038
DBN	1 0.345	0.780	0.862	0.695
	2 0.007	0.348	0.396	0.083
ED	1 0.508	0.951	0.669	0.986
	2 0.006	0.115	0.920	0.011
HL	1 0.013	0.405	0.050	0.194
	2 0.043	0.749	0.317	0.415
HW	1 0.004	0.070	0.235	0.011
	2 0.527	0.034	0.407	0.034
PL	1 0.013	0.105	0.001	0.020
	2 0.519	0.017	0.024	0.016
PW	1 0.027	0.001	0.032	0.000
	2 0.307	0.000	0.038	0.001
FLL	1 0.037	0.977	0.137	0.749
	2 0.088	0.023	0.174	0.004
HLL	1 0.005	0.719	0.175	0.422
	2 0.171	0.096	0.169	0.026
DFHL	1 0.177	0.902	0.431	0.696
	2 0.118	0.213	0.009	0.079
HDPBT	1 0.098		0.098	
	2 0.598		0.598	
HW/HL	1 0.000	0.209	0.000	0.519
TL/TBL	1 0.000	0.457	0.000	0.114
PW/PL	1 0.000	0.135	0.000	0.289
NED/HL	1 0.184	0.947	0.018	0.718



Figure 2. Çiçekli village, Ula specimens. Female (above), Male (middle), Juvenile (below).



Figure 3. 6 km north of Marmaris (type locality) specimens. Female (below), Male (upper right), Juvenile (upper left).



Figure 4. Boğaz Island specimens. Male (left), Female (middle), subadult female (right).



Figure 5. Kötekli specimens. Female (above), Male (middle), Juvenile (below).

biotopes of known and new populations (especially near Akyaka, Fig. 8b) were under heavy habitat destruction by humans during our visits. The landscape modifications included uncontrolled agricultural developments, cutting trees, construction, and maintenance work for the touristic actions are likely some of the reasons of



Figure 6. Thera Antique City, near Doğan specimens.
Female (above), Male (middle), Juvenile (below).



Figure 7. Near Akyaka, Ula specimens (since Kuyucak and Sakartepe specimens are similar to Akyaka specimens, additional figures are not given).



Figure 8. General views of the habitats of new populations of *L. f. ilgazi*. (a) Thera Antique City, near Doğan; (b) near Akyaka, Ula; (c) Sakartepe, near Kızılıağac, Ula; (d) Kuyucak.

local population decline (Fig. 8).

When Üzüm et al. (2015) described the ssp. *ilgazi* based on eight specimens from Kötekli they were compared only with seven Çiçekli village specimens; no comprehensive comparison with the nominotypic subspecies' populations, especially the topotypical population (6 km north of Marmaris) and Boğaz Island population (this locality is not even mentioned in the paper). As a taxonomic rule, subspecies descriptions must be

given after detailed comparison with the type locality specimens. In addition, the Boğaz Island population is given and shown in the distribution map by Başoğlu et al. (1994), and it was afterwards confirmed by Veith et al. (2001).

In conclusion, we found several new localities for both subspecies and compared specimens morphologically in detail. According to our results, the two subspecies are morphologically somewhat different from each other. The

endangered Marmaris salamander, *Lyciasalamandra flavimembris*, needs further investigations for possible new populations and range extension, conservation actions and detailed molecular genetic analysis for subspecific taxonomic status.

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