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TAXONOMICAL AND BIOLOGICAL COMPARISON OF TWO LUSCHAN'S LYCIAN SALAMANDER, *Lyciasalamandra luschani* (Steindachner, 1891) (URODELA: SALAMANDRIDAE) POPULATIONS FROM SOUTHWESTERN ANATOLIA

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ABSTRACT. *We report on a new population of Luschan's Lycian Salamander discovered near Karadere village, Eşen, Fethiye-Muğla province, during scientific fieldwork in February 2011. In order to determine its taxonomic status, the Karadere population was examined morphologically, serologically and ecologically; and compared with the nearest population known; the nominate race Lyciasalamandra luschani luschani from the type locality at Dodurga village, Muğla province. For the morphological analysis, we compared a total 44 individuals [Dodurga: 6♂♂, 13♀♀, 3 juv.; and Karadere: 6♂♂, 13♀♀, 3 juv.] based on our material collected in the field and the that present in the ZDEU (Zoology Department of Ege University) collection. Furthermore, electrophoretic studies were carried out with blood serum proteins, and compared with morphometric and colour-pattern characters between these two Luschan's Lycian Salamander populations. The results shows considerable morophological and serological differences between the Karadere population and the nominate race (Lyciasalamandra luschani luschani). It would be better to accept it as an intermediate population with the neighboring subspecies of Luschan's Lycian Salamander, Lyciasalamandra luschani basoglui with the mentioned above differences and primary genetical indications. Also, we elaborate a brief history of Luschan's Lycian Salamander, Lyciasalamandra luschani.*

KEY WORDS: *Lycian salamander, Lyciasalamandra luschani, taxonomy, morphology, serology, Turkey.*

INTRODUCTION

The first Lycian salamander specimens were collected by Prof. Luschan in 1884 from the village Dodurga (Tortukar), Eşen, Fethiye-Muğla province. The Luschan's Lycian Salamander was described with these specimens by Steindachner in 1891 as *Molge luschani*. Only one year later, these salamander were transferred to the genus *Salamandra* by Boulenger in 1892. Werner (1902) and Nikol'skii (1918) supported Boulenger's idea and accepted this terrestrial salamander species as *Salamandra luschani*.

On the other hand, a semi-aquatic salamander species was described by Waga in 1876 from Caucasia and northeastern Anatolia as *Exaeretus caucasica*. Wolterstorff (1925) indicated that the males of these two species (*Exaeretus caucasica* and *Salamandra luschani*) shared similar morphological characteristics (dorsal protuberance at base of the tail), that was not found in any other salamander species and consequently, described the genus *Mertensiella* for these Lycian Salamanders. Since Özeti (1967)'s study on Turkish salamanders, Luschan's Lycian Salamander was accepted as *Mertensiella luschani*. Özeti (1967) suggested that based on comparative osteological studies, the genus *Mertensiella* should be accepted as subgenus of *Salamandra* [*Salamandra (Mertensiella) luschani*].

The second geographic race of the Luschan's Lycian Salamander was described by Başoğlu & Atatür (1975) from Finike, Antalya province, as *Mertensiella luschani finikensis* and thus, the Dodurga population became the nominate race (*Mertensiella luschani luschani*). The last known subspecies of the Luschan's Lycian Salamander was described by Baran & Atatür (1980) from Kaş, Antalya province, as *Mertensiella luschani basoglui*.

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 addtion,

all species of the genus *Lyciasalamandra,* except the *Lyciasalamandra luschani* subspecies (*L. l. luschani, L. l. basoglui* and *L. l. finikensis*), were raised to species level by detailed and comprehensive studies (Weisrock et al. 2001, Veith & Steinfartz 2004).

Since Steindachner's description, fourteen new Lycian salamander taxa have been diagnosed (Pieper 1963, Başoğlu 1967, Başoğlu & Atatür 1974,75, Başoğlu & Baran 1976, Baran & Atatür 1980, Franzen & Klewen 1987, Mutz & Steinfartz 1995, Göçmen et al. 2011, Göçmen & Akman 2012, Akman & Godmann 2014, Üzüm et al. 2015, Yıldız & Akman 2015).

At present, *Lyciasalamandra* contains a total of fifteen taxa within an area of approximately 390 km along the Mediterranean coast of Turkey between Gazipaşa, Antalya and Marmaris, Muğla provinces, and some neaby offshore islands (Veith et al. 2001, Öz et al. 2004, Akman et al. 2011, Göçmen et al. 2013). On the other hand, *Lyciasalamandra luschani luschani* has only a 35 km distribution range (north-south direction) from the northern part of Babadağ Mountain (Patlangıç district) to the Letoon locality in Fethiye, Muğla province its altitude range between 30-570 m asl (Mutz 1994, Akman et al. 2013).

To clarify the taxonomic status and compare the population living in the Belceğiz Lycian way, Karadere, with the population from the type locality (Dodurga), we conducted excursions in February 2011 and 2012. Although we found approximately 50 specimens, only 22 from Karadere and 9 from Dodurga were collected, in consideration of their threatened conservation status. We matched the number of specimens from Dodurga with the preserved conspecific specimens at ZDEU to obtain sufficient data for a sound comparison of mensural characters. As a result of our survey, we concluded that the Lycian salamander population in Belceğiz Lycian way, Karadere, Muğla province, represents an intermediate population between *L. l. luschani* and *L. l. basoglui*, likewise Letoon population which was proved by Vetih et al. (2008).

MATERIALS AND METHODS

The *Lyciasalamandra luschani luschani* material for the morphological

comparisons consist of 22 (6♂♂, 13♀♀, 3 juv.) specimens from the type locality Dodurga, both ZDEU (The Zoology Department of Ege University, Izmir, Turkey) and new material gathered in February 2011, and 22 (6♂♂, 13♀♀, 3 juv.) specimens collected from the Karadere population in February 2011, 2012 which are deposited in Zoology Museum of Adıyaman University (ZMADYU). Studied materials are listed below.

Dodurga (N=22): ZMADYU 2011/93: (N=9): 1 ♂; 2-6 ♀♀; 7-9 juv, Dodurga/Muğla, 14.02.2011, B. GÖÇMEN, M. KARIŞ. Coordinates 36°24'N and 29°11'E. ZDEU 1980/1: (N=11): 3, 6, 9, 12, 13, 14, 15, 19 ♀♀; 4, 11, 16 ♂♂, Dodurga/Muğla, 19.02.1980, H. ARIKAN, S. ÜÇÜNCÜ. ZDEU 1981/4: (N=2): 3, 8 ♂♂, Dodurga/Muğla, 07.03.1981, S. SEZER, S. ÜÇÜNCÜ.

Karadere (N=22): ZMADYU 2011/92: (N=9): 1, 3, 4 ♂♂; 2, 5, 6, 7 ♀♀; 8, 9 juv., Karadere/Muğla, 14.02.2011, B. GÖÇMEN, M. KARIŞ. ZMADYU 2012/39: (N=13): 1-3 ♂♂; 4-12 ♀♀; 13 juv., Karadere/Muğla, 27.02.2012, B. GÖÇMEN, B. AKMAN, N. İĞCİ, M. VEITH, O. GODMANN.

A distribution map of the *Lyciasalamandra luschani luschani* and neighboring taxa as well as the study site is given in Figure 1. Although the geographical

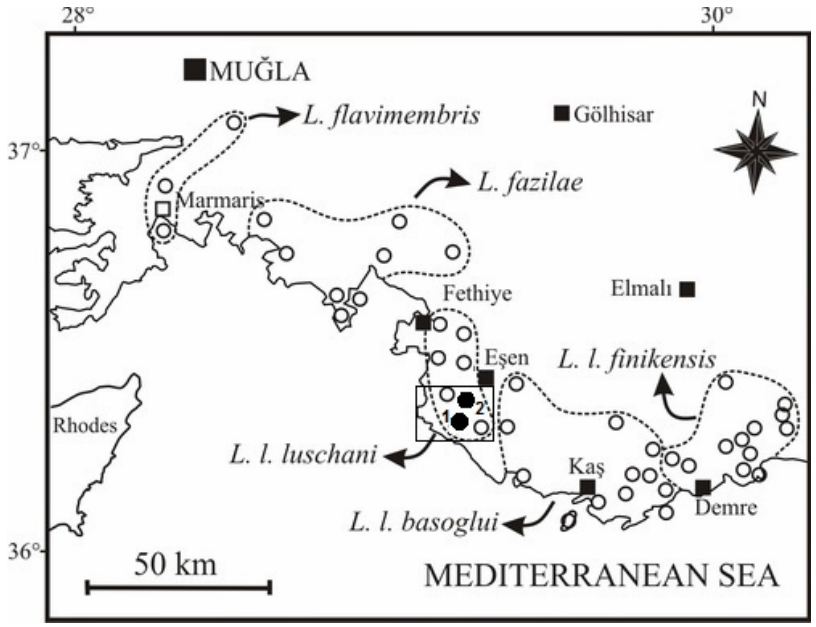

Figure 1. Actual distribution map of the *Lyciasalamandra luschani luschani* and neighbouring taxa. Square indicates study area (1- Karadere population, 2- Dodurga population).

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.

Collected specimens were kept alive for a period in properly prepared aqua-terrariums for colouration analysis, photography and behavior observations. Photographs are taken with Olympus C-5060WZ and Nikon Coolpix 5400 digital cameras.

To facilitate intra- and interpopulation comparisons regarding blood-serum proteins, polyacrylamide gel electrophoresis (PAGE) and densitometric analyses were utilized. Blood samples were obtained in the laboratory within three days of collection after anaesthetizing with ether, by ventral abdominal vein puncture with heparinized hematocrit capillaries. The separations of blood-serum proteins followed the polyacrylamide "disc" electrophoresis method of Davis (1964), slightly modified by Özeti & Atatür (1979) and Arıkan (1983).

Following the serological procedures, 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 depozited in Zoology Museum of Adıyaman University (ZMADYU).

We applied "Student T" test analyses to evaluate potential sexual dimorphism in each population, as well as for inter-population differences, either separated by sex or lumped, if there was no gender difference. For mensural (metric) character comparison we used also sum adults (higher value of 80 mm by Total Body Length), to avoid effects of allometry.

Metric characters were measured with a Mitutoyo digital caliper of 0.02 mm sensitivity, 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's of rostrum-anus length; [each metric character / RA] × 100), according to Werner (1971), which improved the analysis. The evaluations 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 posterior end 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 gular fold (HL), Head Width (HW), Parotid Length

(PL), Parotid Width (PW), Fore Limb Length (FLL), Hind Limb Length (HLL), Distance between Fore- and Hind Limbs (DFHL), Height of dorsal protuberance on base of the tail (HDPBT) – only in males. Some of the mensural characters and body proportions are shown in Figure 2.

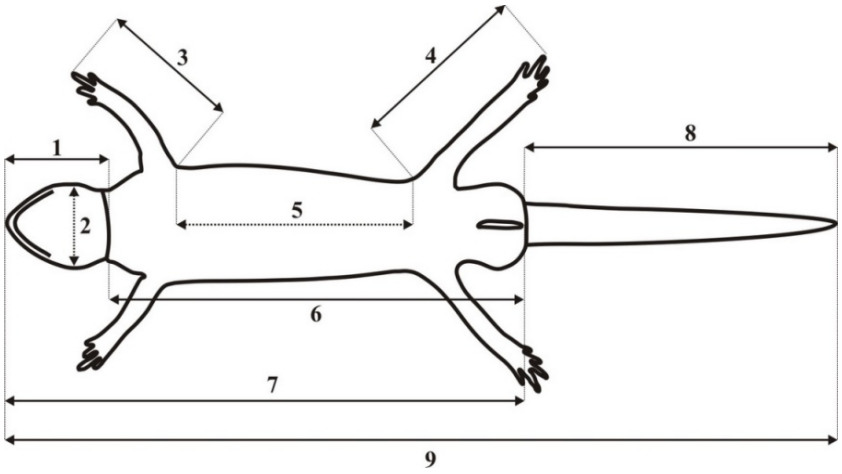

Figure 2. Measured body proportions and mensural characters of the specimens (ventral side) 1- Head Length, 2- Head Width, 3- Fore Limb Length, 4- Hind Limb Length, 5- Distance between Fore and Hind Limbs, 6- Length of Trunk, 7- Rostrum-Anus Length, 8- Tail Length, 9- Total Body Length.

Computed characters (ratios): Ratios of the characters HW/HL, TL/TBL, PW/PL, NED/HL and all characters/RA x 100 (PERCRA) were also computed and compared with Student T test.

RESULTS AND DISCUSSION

Dodurga Population

Mensural and Computed Characters

For presentation of the measurements, adults (13 female, 6 male) and juveniles (3) are grouped and descriptive statistics are given separately. Since Student 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 and P values from the raw data, ratios and PERCRA indices are given in Table 1. The abbreviations are given in the Material and Method section.

According to Student T test (see Table 1), we determined some statistically significant (P≤0.05) differences between males and females in terms of characters from the raw data (TBL, RA, LT, TL, PW, FLL, HLL), and by the PERCRA index values (LT, HL, HW, PL, PW).

Colouration and Pattern

Colour pattern characteristics of Dodurga population are evaluated and separated into two types (Type-I, Type-II). Juvenile specimens are not included for this evaluation, because of their greater colour pattern variation. But juveniles generally have Type-I, Type-II or a combination of these two patterns.

Type-I specimens have a light brown dorsum ground colour with irregularly scattered blackish dark brown blotches and whitish to light yellow flecks. The middle part of the upper eyelids are dark brown or black while anterior and posterior parts are light yellow. Posterior part of parotoid gland wider than anterior part. These glands generally are yellowish to light brown (lighter than dorsum ground colour). The ground colour of tail is lighter than dorsum (orangish light brown) with few brown macules. Extremities have a similar colouration as the tail (flesh coloured), and there are some irregularly scattered dark brown and yellowish white spots. A whitish lateral band occurs on both sides, but it is not complete (fragmented). The ventral side of the trunk is not pigmented. Abdominal internal organs are visible. Thirteen of 19 adult and sub-adult specimens (68.42%) have Type-I colouration and pattern (Figure 3-A, B).

Type-II specimens have an orangish light brown dorsal ground colouration. Dark brown blotches are dominant on this ground colour with irregularly scattered yellowish-white flecks. Upper eyelids have greenish light yellow colour with dark (blackish) mid part. The other body proportions have similar colouration and pattern as in Type-I. Six of 19 adult and sub-adult specimens (31.58%) have Type-II colouration and pattern (Figure 3-C, D).

Table 1. Summarized statistics of some mensural characters (in mm) and ratios, also T-test analyses results showing sexual dimorphism (bold) of the Dodurga specimens. 1: Raw data; 2: PERCRA; N: number of specimens; SD: Standard deviation; SE: Standard error of mean; P≤0.05. The other abbreviations of characters were given in Materials and Methods.

Characters		♂♂						T-Test	♀♀					
		N	Mean	Min.	Max.	SD	SE	P	N	Mean	Min.	Max.	SD	SE
TBL	1	6	118.33	114.00	123.00	3.27	1.333	**0.026**	13	108.38	85.00	125.00	13.62	3.778
	2	6	180.43	171.43	191.80	7.05	2.876	0.692	13	179.17	171.88	184.85	3.38	0.938
RA	1	6	65.67	61.00	70.00	3.08	1.256	**0.042**	13	60.46	48.00	69.00	7.22	2.002
LT	1	6	51.78	46.65	55.28	2.90	1.185	**0.032**	13	46.69	35.71	54.66	6.56	1.820
	2	6	78.82	76.48	79.75	1.22	0.498	**0.028**	13	77.04	74.40	79.55	1.92	0.532
TL	1	6	52.67	49.00	56.00	2.94	1.202	**0.044**	13	47.92	37.00	56.00	6.58	1.824
	2	6	80.43	71.43	91.80	7.05	2.876	0.692	13	79.17	71.88	84.85	3.38	0.938
NED	1	6	2.69	2.21	3.17	0.34	0.140	0.196	13	2.47	1.98	2.97	0.27	0.075
	2	6	4.12	3.30	5.20	0.67	0.272	0.965	13	4.10	3.57	4.92	0.41	0.114
DBN	1	6	4.11	3.70	4.64	0.32	0.129	0.099	13	3.79	2.99	4.29	0.46	0.126
	2	6	6.28	5.52	7.61	0.72	0.293	0.975	13	6.27	5.97	6.68	0.19	0.053
ED	1	6	4.34	4.00	5.04	0.41	0.169	0.534	13	4.21	3.51	5.02	0.46	0.128
	2	6	6.64	5.71	8.26	0.89	0.364	0.411	13	6.99	6.27	7.91	0.63	0.174
HL	1	6	13.89	12.96	14.72	0.69	0.280	0.753	13	13.77	12.06	14.96	0.92	0.255
	2	6	21.18	20.25	23.52	1.22	0.498	**0.028**	13	22.95	20.45	25.60	1.92	0.532
HW	1	6	10.83	10.05	11.55	0.60	0.247	0.909	13	10.78	9.03	11.93	0.96	0.265
	2	6	16.52	15.60	18.93	1.30	0.529	**0.048**	13	17.92	16.10	19.55	0.99	0.273

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Table 1. (Continuing)

Characters		Juveniles						Sum Adults					
		N	Mean	Min.	Max.	SD	SE	N	Mean	Min.	Max.	SD	SE
TBL	1	3	73.67	71.00	78.00	3.79	2.186	19	111.53	85.00	125.00	12.22	2.803
	2	3	179.77	177.27	182.05	2.40	1.384	19	179.56	171.43	191.80	4.67	1.071
RA	1	3	41.00	39.00	44.00	2.65	1.528	19	62.11	48.00	70.00	6.60	1.514
LT	1	3	30.50	28.05	33.58	2.82	1.627	19	48.30	35.71	55.28	6.08	1.394
	2	3	74.31	71.92	76.32	2.22	1.283	19	77.61	74.40	79.75	1.90	0.435
TL	1	3	32.67	32.00	34.00	1.15	0.667	19	49.42	37.00	56.00	6.03	1.384
	2	3	79.77	77.27	82.05	2.40	1.384	19	79.56	71.43	91.80	4.67	1.071
NED	1	3	1.85	1.66	2.06	0.20	0.116	19	2.54	1.98	3.17	0.31	0.070
	2	3	4.51	4.15	4.69	0.31	0.179	19	4.11	3.30	5.20	0.48	0.111
DBN	1	3	2.42	2.11	2.61	0.27	0.156	19	3.89	2.99	4.64	0.44	0.100
	2	3	5.91	5.28	6.51	0.62	0.358	19	6.27	5.52	7.61	0.41	0.094
ED	1	3	3.08	2.93	3.26	0.17	0.096	19	4.25	3.51	5.04	0.44	0.101
	2	3	7.52	7.41	7.63	0.11	0.062	19	6.88	5.71	8.26	0.71	0.164
HL	1	3	10.50	10.12	10.95	0.42	0.243	19	13.81	12.06	14.96	0.83	0.191
	2	3	25.69	23.68	28.08	2.22	1.283	19	22.39	20.25	25.60	1.89	0.434
HW	1	3	7.57	7.33	7.98	0.36	0.206	19	10.80	9.03	11.93	0.84	0.194
	2	3	18.48	18.14	18.97	0.44	0.254	19	17.47	15.60	19.55	1.25	0.286

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Table 1. (Continuing)

Characters		♂♂						T-Test	♀♀					
		N	Mean	Min.	Max.	SD	SE	P	N	Mean	Min.	Max.	SD	SE
PL	1	6	6.99	6.78	7.35	0.20	0.084	0.305	13	7.22	5.68	8.13	0.73	0.203
	2	6	10.66	9.87	12.05	0.74	0.304	**0.006**	13	12.00	9.62	13.80	1.01	0.280
PW	1	6	2.30	1.93	2.51	0.21	0.085	**0.035**	13	2.65	1.64	3.39	0.45	0.126
	2	6	3.50	2.97	3.87	0.31	0.127	**0.002**	13	4.40	3.42	5.93	0.73	0.204
FLL	1	6	20.88	18.69	22.09	1.22	0.500	**0.014**	13	18.79	14.75	21.71	2.06	0.570
	2	6	31.90	26.70	35.79	2.95	1.203	0.560	13	31.13	29.46	33.80	1.16	0.323
HLL	1	6	22.59	21.70	23.35	0.62	0.252	**0.050**	13	21.07	17.42	24.79	2.47	0.685
	2	6	34.45	31.96	37.16	1.68	0.686	0.587	13	34.88	33.41	36.79	1.13	0.313
DFHL	1	6	36.61	33.68	40.88	2.72	1.110	0.102	13	33.46	24.94	40.35	5.21	1.444
	2	6	55.93	51.49	67.02	6.04	2.464	0.788	13	55.19	48.08	61.14	3.49	0.969
HDPBT	1	6	3.43	3.01	3.75	0.30	0.123							
	2	6	5.23	4.70	6.05	0.53	0.215							
HW/HL	1	6	0.78	0.73	0.83	0.04	0.015	0.862	13	0.78	0.69	0.88	0.05	0.015
TL/TBL	1	6	0.45	0.42	0.48	0.02	0.009	0.726	13	0.44	0.42	0.46	0.01	0.003
PW/PL	1	6	0.33	0.28	0.36	0.03	0.012	0.064	13	0.37	0.26	0.46	0.05	0.015
NED/HL	1	6	0.19	0.15	0.22	0.03	0.011	0.256	13	0.18	0.15	0.22	0.02	0.005

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Table 1. (Continuing)

Characters		Juveniles						Sum Adults					
		N	Mean	Min.	Max.	SD	SE	N	Mean	Min.	Max.	SD	SE
PL	1	3	5.08	4.90	5.19	0.16	0.090	19	7.14	5.68	8.13	0.62	0.141
	2	3	12.41	11.80	13.18	0.71	0.407	19	11.58	9.62	13.80	1.11	0.255
PW	1	3	1.64	1.49	1.74	0.13	0.075	19	2.54	1.64	3.39	0.42	0.097
	2	3	4.00	3.73	4.31	0.29	0.169	19	4.11	2.97	5.93	0.75	0.173
FLL	1	3	11.53	11.06	11.84	0.41	0.238	19	19.45	14.75	22.09	2.06	0.472
	2	3	28.17	26.91	29.95	1.58	0.915	19	31.37	26.70	35.79	1.86	0.426
HLL	1	3	12.97	12.48	13.42	0.47	0.272	19	21.55	17.42	24.79	2.17	0.497
	2	3	31.68	30.50	33.33	1.48	0.852	19	34.75	31.96	37.16	1.29	0.297
DFHL	1	3	22.63	21.89	23.47	0.79	0.459	19	34.45	24.94	40.88	4.73	1.086
	2	3	55.28	53.34	57.77	2.27	1.308	19	55.43	48.08	67.02	4.29	0.984
HDPBT	1	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-
HW/HL	1	3	0.72	0.68	0.77	0.05	0.026	19	0.78	0.69	0.88	0.05	0.011
TL/TBL	1	3	0.44	0.44	0.45	0.01	0.004	19	0.44	0.42	0.48	0.01	0.003
PW/PL	1	3	0.32	0.30	0.34	0.02	0.009	19	0.35	0.26	0.46	0.05	0.011
NED/HL	1	3	0.18	0.16	0.20	0.02	0.011	19	0.18	0.15	0.22	0.02	0.005

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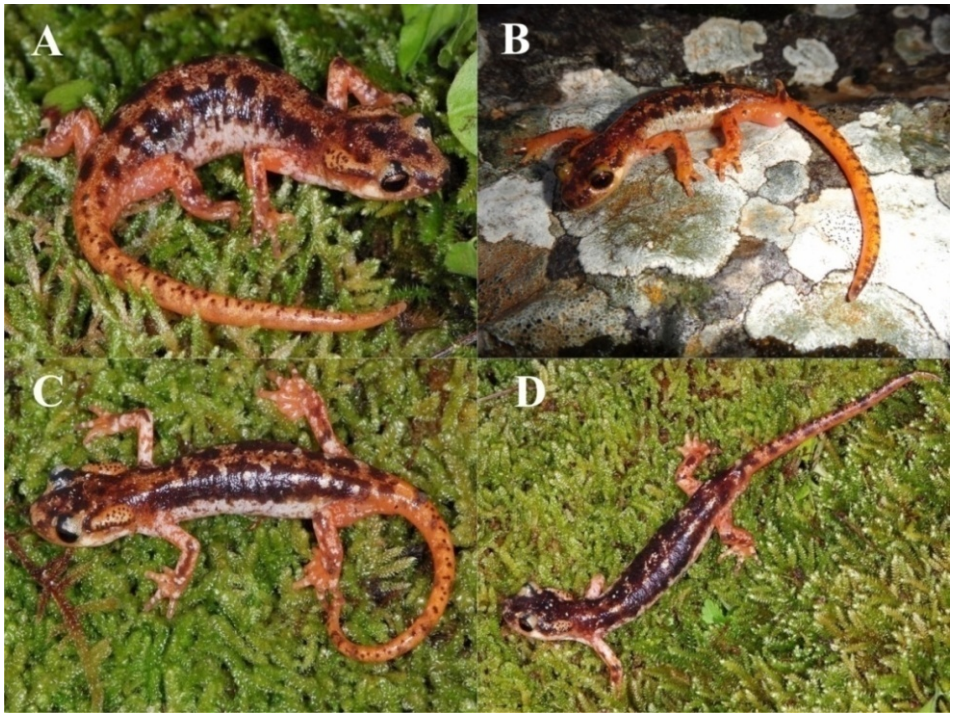

Figure 3. Colouration and pattern types of the Dodurga specimens.
A: Type-I female, B: Type-I male, C: Type-II female, D: Type-II male.

In both types, secretory adenoid gland openings (black dots) are irregularly scattered on parotoids. These openings also occur on median part of the tail, irregularly, while on dorsum regularly (Figure 4-A, B, C).

The dorsal protuberance at the base of the tail is brown coloured with a yellowish tip in males and it is little or not curved to the anterior. Also, the cloacal region is swollen in male specimens (Figure 4-D).

Serological Evaluations

We obtained the blood samples from 1 sub-adult and 1 adult female specimen from the Dodurga population. We detected 12 protein fractions: 10 globulin and 2 albumin (1 pre-albumin, 1 albumin) in the sub-adult female; and 13 protein fraction: 11 globulin, 2 albumin (1 pre-albumin, 1 albumin) in the adult female, respectively (Figure 5). As a remarkable

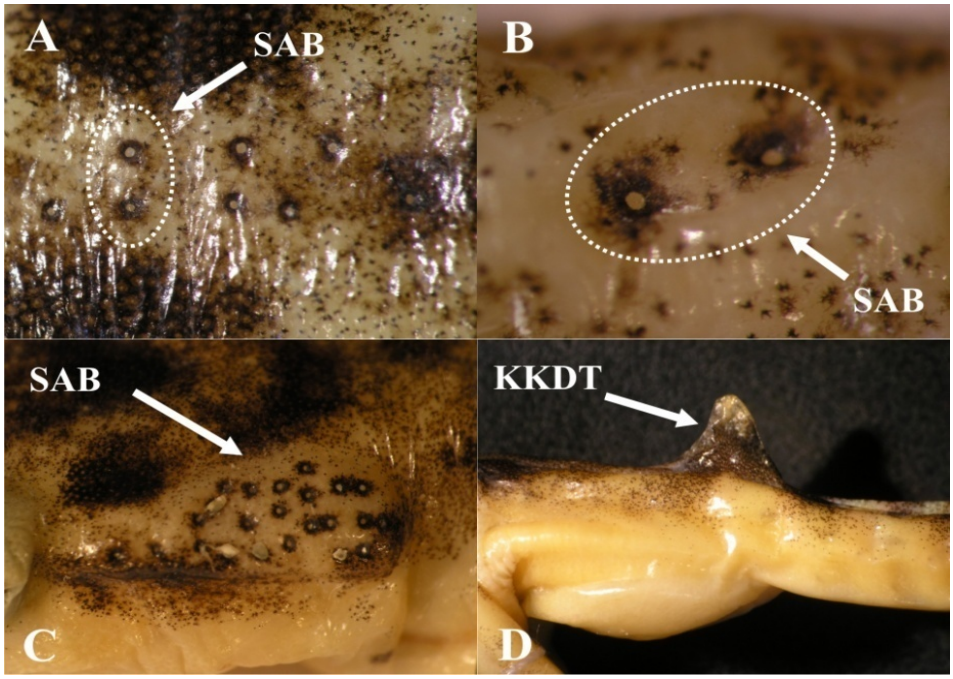

Figure 4. Aspect of the secretory adenoid gland openings (SAB) of female (ZMADYU 2011/93-3♀) in Dodurga population. A- On dorsum (regular double-row), B- On tail (irregular single file), C- On parotoid gland (irregularly scattered), and D- hedonic (KKDT) and cloacal region of the male (ZMADYU 2011/93-1♂).

result, there is an age-dependent variation in term of blood-serum proteins in Dodurga specimens.

Biological and Ecological Remarks

We conducted two field trips during the active season of Lycian salamanders (February, 2011 and 2012) to Dodurga, Muğla province (at coordinates 36°24'N and 29°11'E). We found 9 specimens (1 male, 2 female, 3 sub-adult female, 3 juvenile) under stones on a rainy day. Temperature was 14 °C. Altitude was around 570 m asl. Habitat of the Dodurga population has plenty of karstic limestone covered with luscious vegetation.

General flora was characterized by maquis scrubland, frigana and olive

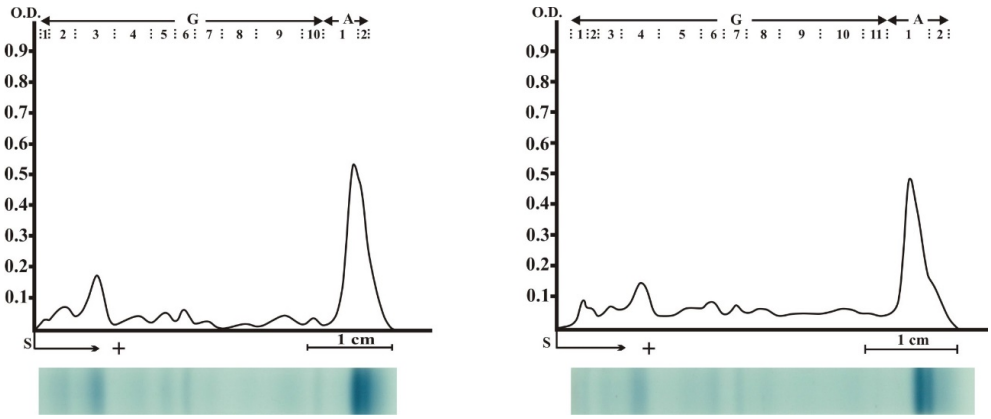

Figure 5. Electropherograms representing the electrophoretic separations of blood serum proteins (left: sub-adult female, right: adult female) in Dodurga specimens together with their corresponding densitometric curves [OD: optical density. S: start -the border between the stacking and separation gels- . G: globulin-like proteins zone. A: albumin-like proteins zone.

trees. Common plants in habitat this were; *Pinus brutia*, *Olea europaea sylvestris*, *Styrax officinalis*, *Vitex agnus-castus*, *Nerium oleander*, *Quercus macrolepis*, *Colchicum* sp., *Cistus creticus*, *Ceratonia siliqua*, *Laurus nobilis*, *Euphorbia dendroides* and *Sarcopoterium spinosum*. Also, the karstic limestones were covered with green *Sphagnum* sp. (Bryophyte).

Various herptiles occurred sympatric with Dodurga population; *Pelophylax bedriagae*, *Bufotes variabilis*, *Anatololacerta oertzeni pelasgiana*, *Testudo graeca ibera*, *Blanus strauchi bedriagae*, *Pseudopus apodus*, *Lacerta trilineata diplochondrodes*, *Ophisops elegans macrodactylus*, *Ablepharus budaki anatolicus*, *Trachylepis aurata*, *Typhlops vermicularis*, *Eirenis modestus semimaculatus* and *Platyceps najadum* .

As a remarkable behavioral observation, in February 2012, a male specimen became stressed during a photographing session and exhibited his defensive posture (Figure 6).We also would like to point out, that the biotope was under heavy habitat destruction by humans during our visits. The landscape modifications inlcuded uncontrolled agricultural developments, cutting trees, and construction and maintenance work for

the touristic historical Lycian way are likely some of the reasons of local population decline.

Figure 6. Defensive posture of male specimen from Dodurga in February 2012.

Karadere Population

Mensural and Computed Characters

We analyzed and present the descriptive statistics of adults (13 female, 6 male) and juveniles (3) separated into groups. In adults, we found significant differences between the sexes with the Student T test. The characters are first presented for each sex separated and subsequently for all adults combined (juveniles excluded). Summarized statistics and P values from the raw data, ratios and PERCRA indices are given in Table 2. The abbreviations are given in Material and Method section.

According to Student T test (see Table 2), statistically significant ($P \leq 0.05$) sexualdimorphic characters are: raw data: TBL, LT, TL, and for PERCRA index values: (LT, HL, HW, PL, PW).

Colouration and Pattern

Colouration and pattern characters were evaluated based on two

Table 2. Summarized statistics of some mensural characters (in mm) and ratios, also T-test analyses results showing sexual dimorphism (bold) of the Karadere specimens. 1: Raw data; 2: PERCRA; N: number of specimens; SD: Standard deviation; SE: Standard error of mean; P≤0.05. The other abbreviations of characters were given in Materials and Methods.

Characters		♂♂						T-Test	♀♀					
		N	Mean	Min.	Max.	SD	SE	P	N	Mean	Min.	Max.	SD	SE
TBL	1	6	126.67	124.00	131.00	2.34	0.955	**0.050**	13	120.23	95.00	131.00	10.79	2.994
	2	6	179.25	176.39	181.94	2.00	0.816	0.212	13	177.90	172.73	180.56	2.19	0.609
RA	1	6	70.67	69.00	72.00	1.21	0.494	0.072	13	67.54	55.00	73.00	5.52	1.530
LT	1	6	54.90	53.59	56.23	1.01	0.412	**0.025**	13	51.56	41.29	55.83	4.58	1.270
	2	6	77.69	77.24	78.19	0.39	0.158	**0.000**	13	76.30	75.07	78.25	0.95	0.263
TL	1	6	56.00	55.00	59.00	1.55	0.632	**0.050**	13	52.69	40.00	58.00	5.33	1.478
	2	6	79.25	76.39	81.94	2.00	0.816	0.212	13	77.90	72.73	80.56	2.19	0.609
NED	1	6	2.70	2.54	2.95	0.16	0.064	0.732	13	2.66	2.23	3.06	0.26	0.072
	2	6	3.82	3.61	4.28	0.25	0.103	0.333	13	3.95	3.60	4.38	0.27	0.076
DBN	1	6	3.94	3.60	4.44	0.33	0.135	0.450	13	4.06	3.54	4.43	0.27	0.075
	2	6	5.58	5.07	6.34	0.48	0.195	0.072	13	6.03	5.71	6.64	0.30	0.084
ED	1	6	4.67	4.32	4.87	0.20	0.081	0.248	13	4.51	3.95	5.03	0.35	0.097
	2	6	6.60	6.17	7.01	0.33	0.135	0.594	13	6.69	6.20	7.18	0.31	0.085
HL	1	6	15.77	15.27	16.16	0.36	0.148	0.533	13	15.98	13.71	17.32	1.08	0.299
	2	6	22.31	21.81	22.76	0.39	0.158	**0.000**	13	23.70	21.75	24.93	0.90	0.251
HW	1	6	11.55	11.24	11.71	0.18	0.073	0.675	13	11.65	9.79	12.63	0.78	0.217
	2	6	16.35	15.61	16.97	0.45	0.185	**0.002**	13	17.27	16.57	18.15	0.48	0.133

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Table 2. (Continuing)

Characters		Juveniles						Sum Adults					
		N	Mean	Min.	Max.	SD	SE	N	Mean	Min.	Max.	SD	SE
TBL	1	3	70.00	69.00	72.00	1.73	1.000	19	122.26	95.00	131.00	9.42	2.160
	2	3	172.13	168.29	175.61	3.67	2.120	19	178.33	172.73	181.94	2.18	0.499
RA	1	3	40.67	40.00	41.00	0.58	0.333	19	68.53	55.00	73.00	4.79	1.099
LT	1	3	30.36	29.65	30.79	0.62	0.358	19	52.62	41.29	56.23	4.10	0.940
	2	3	74.65	74.13	75.10	0.49	0.284	19	76.74	75.07	78.25	1.04	0.238
TL	1	3	29.33	28.00	31.00	1.53	0.882	19	53.74	40.00	59.00	4.70	1.078
	2	3	72.13	68.29	75.61	3.67	2.120	19	78.33	72.73	81.94	2.18	0.499
NED	1	3	1.76	1.72	1.79	0.04	0.021	19	2.67	2.23	3.06	0.23	0.052
	2	3	4.33	4.30	4.37	0.03	0.020	19	3.91	3.60	4.38	0.27	0.061
DBN	1	3	2.76	2.63	3.01	0.22	0.125	19	4.03	3.54	4.44	0.29	0.066
	2	3	6.79	6.41	7.34	0.49	0.283	19	5.89	5.07	6.64	0.41	0.095
ED	1	3	3.10	2.99	3.19	0.10	0.059	19	4.56	3.95	5.03	0.31	0.072
	2	3	7.63	7.29	7.83	0.30	0.171	19	6.66	6.17	7.18	0.31	0.071
HL	1	3	10.31	10.21	10.36	0.08	0.048	19	15.91	13.71	17.32	0.91	0.208
	2	3	25.35	24.90	25.88	0.49	0.284	19	23.26	21.75	24.93	1.01	0.233
HW	1	3	8.10	8.09	8.12	0.02	0.010	19	11.62	9.79	12.63	0.65	0.148
	2	3	19.92	19.73	20.23	0.27	0.154	19	16.98	15.61	18.15	0.64	0.146

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Table 2. (Continuing)

Characters		♂♂						T-Test	♀♀					
		N	Mean	Min.	Max.	SD	SE	P	N	Mean	Min.	Max.	SD	SE
PL	1	6	7.48	7.31	7.79	0.17	0.070	0.177	13	7.78	6.17	8.97	0.74	0.205
	2	6	10.58	10.26	11.13	0.35	0.144	**0.000**	13	11.52	11.01	12.46	0.46	0.128
PW	1	6	2.76	2.50	2.97	0.18	0.075	0.141	13	2.93	2.36	3.23	0.26	0.073
	2	6	3.91	3.57	4.25	0.25	0.102	**0.008**	13	4.33	4.09	4.55	0.11	0.032
FLL	1	6	21.03	20.45	21.69	0.39	0.161	0.176	13	20.37	16.83	22.09	1.57	0.434
	2	6	29.77	28.40	30.99	0.92	0.377	0.369	13	30.19	28.85	31.67	0.82	0.228
HLL	1	6	24.93	24.03	25.86	0.68	0.277	0.366	13	24.29	19.61	26.89	2.25	0.623
	2	6	35.28	34.33	36.94	1.00	0.409	0.211	13	35.95	34.10	37.87	1.05	0.291
DFHL	1	6	38.01	37.03	39.68	0.99	0.403	0.455	13	37.18	29.23	40.53	3.63	1.007
	2	6	53.80	51.89	56.69	1.60	0.652	0.148	13	54.98	53.02	56.76	1.25	0.346
HDPBT	1	6	5.40	5.12	5.89	0.30	0.122	-	-	-	-	-	-	-
	2	6	7.64	7.11	8.41	0.46	0.189	-	-	-	-	-	-	-
HW/HL	1	6	0.73	0.70	0.76	0.02	0.010	0.733	13	0.73	0.70	0.76	0.02	0.005
TL/TBL	1	6	0.44	0.43	0.45	0.01	0.003	0.211	13	0.44	0.42	0.45	0.01	0.002
PW/PL	1	6	0.37	0.32	0.40	0.03	0.013	0.647	13	0.38	0.35	0.41	0.02	0.005
NED/HL	1	6	0.17	0.16	0.19	0.01	0.004	0.461	13	0.17	0.15	0.19	0.01	0.004

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Table 2. (Continuing)

Characters		Juveniles						Sum Adults					
		N	Mean	Min.	Max.	SD	SE	N	Mean	Min.	Max.	SD	SE
PL	1	3	5.09	4.96	5.28	0.17	0.097	19	7.69	6.17	8.97	0.63	0.144
	2	3	12.52	12.27	12.88	0.32	0.185	19	11.23	10.26	12.46	0.61	0.141
PW	1	3	2.10	1.97	2.23	0.13	0.075	19	2.87	2.36	3.23	0.25	0.057
	2	3	5.16	4.80	5.44	0.32	0.186	19	4.20	3.57	4.55	0.26	0.059
FLL	1	3	12.43	12.07	12.91	0.43	0.250	19	20.58	16.83	22.09	1.33	0.306
	2	3	30.57	29.44	31.49	1.04	0.600	19	30.06	28.40	31.67	0.85	0.196
HLL	1	3	14.68	14.26	15.02	0.39	0.222	19	24.49	19.61	26.89	1.89	0.434
	2	3	36.10	34.78	37.55	1.39	0.802	19	35.74	34.10	37.87	1.06	0.242
DFHL	1	3	21.56	21.03	21.95	0.48	0.275	19	37.44	29.23	40.53	3.04	0.697
	2	3	53.03	51.29	54.88	1.79	1.035	19	54.61	51.89	56.76	1.44	0.330
HDPBT	1	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-
HW/HL	1	3	0.79	0.78	0.79	0.01	0.003	19	0.73	0.70	0.76	0.02	0.004
TL/TBL	1	3	0.42	0.41	0.43	0.01	0.007	19	0.44	0.42	0.45	0.01	0.002
PW/PL	1	3	0.41	0.39	0.42	0.02	0.010	19	0.37	0.32	0.41	0.02	0.005
NED/HL	1	3	0.17	0.17	0.17	0.00	0.002	19	0.17	0.15	0.19	0.01	0.003

categories(Type-I, Type-II) for adult specimens, while juveniles treated separately.

In Type-I, dorsal side of the head and trunk exhibit dark brownish bright black ground colour with numerous irregularly scattered white flecks. Colour pattern of tail varies between brown to black, but it is always dark with the regularly distributed white flecks. Males have lighter ground colour than females. Colouration of parotoid glands in males is lighter than its dorsum ground colour, while it has the same colouration in females with dorsum. Upper eyelids have bright yellowish white colouration except the mid part which is black. A fragmented white lateral band occurs on both sides, beginning from posterior of orbits to the base of the hind limbs. Extremities and tail are orangish flesh coloured with brownish black and white maculation. Ventral side is flesh coloured, with a few white spots. 12 of 19 adult and sub-adult specimens (%63.15) have Type-I colouration and pattern (Figure 7-A, C).

Type-II: The dorsal ground colour is shiny black with less number and smaller white flecks than Type-I. Parotoid glands have the same colouration as the dorsum. Because of this dark colouration, secretory gland openings are not visible. Upper eyelids are also blackish in females. Upper eyelids of male specimens are bright greenish yellow except the mid part which is black. Complete white lateral band occur on both sides. Extremities and tail have similar colouration as Type-I. Ventral side of the body is whitish, therefore, abdominal organs are invisible from outside. Seven of 19 adult and sub-adult specimens have Type-II colouration and pattern (Figure 7-C).

Juveniles have brownish dorsal ground colour with yellowish white flecks and brown blotches. Parotoid glands, extremities and tail have similar colouration and pattern to each other but lighter than ground colour of dorsum (Figure 7-D). Venter is less pigmented than in adults.

In both types, secretory adenoid gland openings (black dots) are irregularly scattered on parotoids. These openings also occur on the median part of the tail, irregularly, while regularly on dorsum (Figure 8-A, B, C).

The dorsal protuberance at the base of the tail is bright blackish

Figure 7. Colouration and pattern types of the Karadere specimens.
A: Type-I couple, B: Type-II couple, C: Type-I sub-adult female, D: Juvenile.

coloured with lighter tip in males and it is more or less curving to the anterior. Also, cloacal region is swollen in male specimens (Figure 8-D).

Serological Evaluations

We obtained the blood samples from 1 adult male and 1 adult female specimen from Karadere population. We detected 14 protein fractions which are: 11 globulins, 3 albumins (2 pre-albumin, 1 albumin) in both sexes (Figure 9). As a remarkable result, there is no sex-dependent variation in term of blood-serum proteins in Karadere specimens. Also, blood-serum proteins are found with high density (optical density= 2.0).

Biological and Ecological Remarks

We conducted two field trip during the activity season of Lycian salamanders (February, 2011 and 2012) to a canyon between Karadere

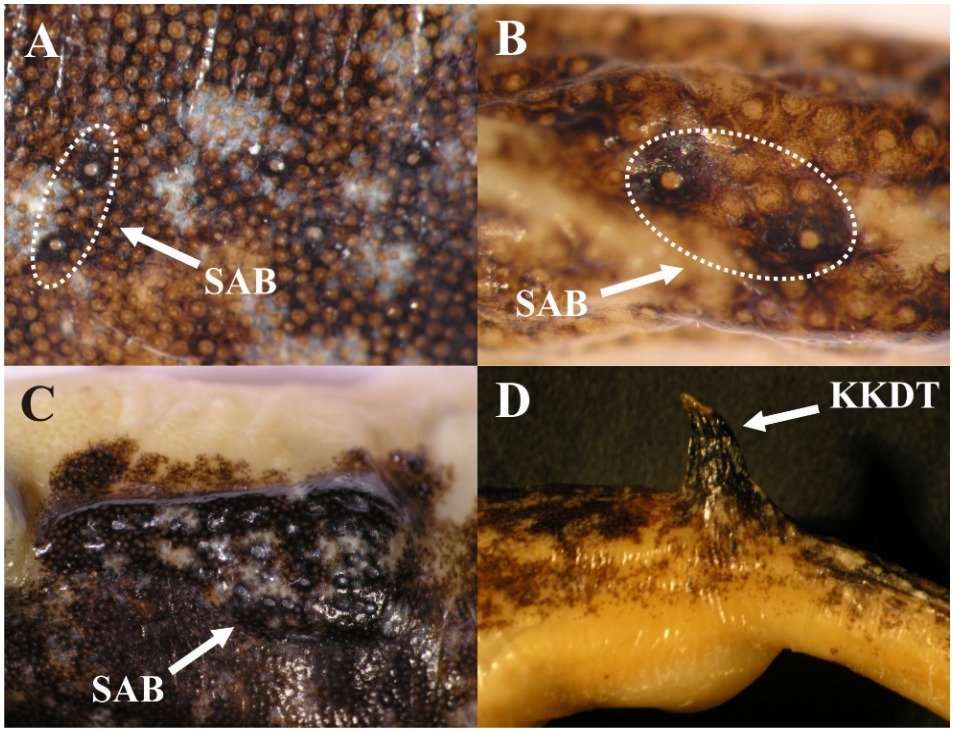

Figure 8. Aspect of the secretory adenoid gland openings (SAB) of female (ZMADYU 2011/92-6♀) in Karadere population. A- On dorsum (regular double-row), B- On tail (irregular single file), C- On parotoid gland (irregularly scattered), and D- hedonic (KKDT) and cloacal region of the male (ZMADYU 2011/92-1♂).

village and Belceğiz Lycian way, Muğla province (at coordinates 36°22'N and 29°13'E). We found 9 specimens (3 male, 3 female, 1 sub-adult female, 2 juvenile) on February 2011 under the stones on a rainy day. Temperature and altitude was 15 °C and 370 m asl., respectively. In February 2012, we detected many specimens but collected only 13 specimens (3 male, 8 female, 1 sub-adult female, 1 juvenile) on a cloudy day at the same site. Temperature was 14 °C. Habitat characteristic is karstic limestones covered with plenty vegetation as typical for all *Lyciasalamandra* members (Figure 10).

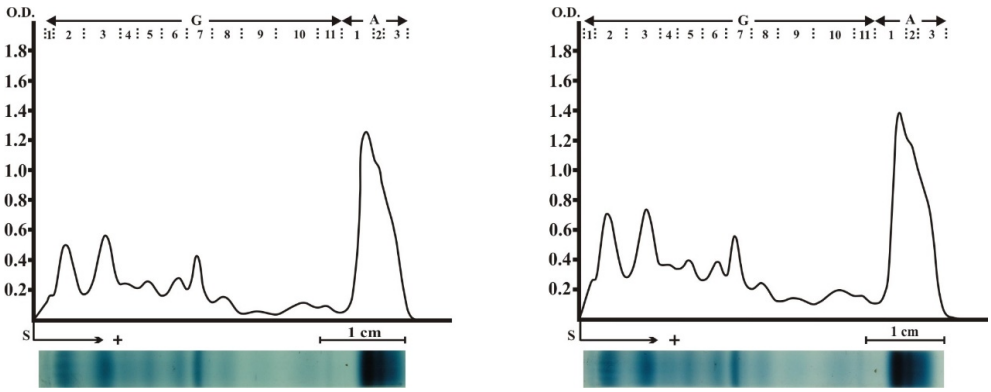

Figure 9. Electropherograms representing the electrophoretic separations of blood serum proteins (left: adult female, right: adult male) in Karadere specimens together with their corresponding densitometric curves [OD: optical density. S: start -the border between the stacking and separation gels- . G: globulin-like proteins zone. A: albumin-like proteins zone.

Figure 10. General view of the characteristic biotope of Karadere population.

Vegetation cover of the biotope can be characterized with forested, maquis scrubland and frigana. Common floral elements on habitat: *Pinus*

brutia, *Nerium oleander*, *Iris* sp., *Acacia cyanophylla*, *Quercus macrolepis*, *Fumana arabica*, *Cakile maritima*, *Solanum alatum*, *Tamarix smyrnensis*, *Laurus nobilis* and *Cynoglossum creticum*. Besides, the karstic limestones were covered with green *Sphagnum* sp. (Bryophyte).

Sympatric amphibians and reptiles are similar as at the Dodurga population. An unusual observation refers to a female (ZMADYU 2012/39-5♀) from the Karadere population with a hedonic protuberance (1.68 mm) at the base of tail, unusually advanced (Figure 11). It is a known situation (a bit swelling tail base) in older female specimens, but smaller than 1 mm and barely visible.

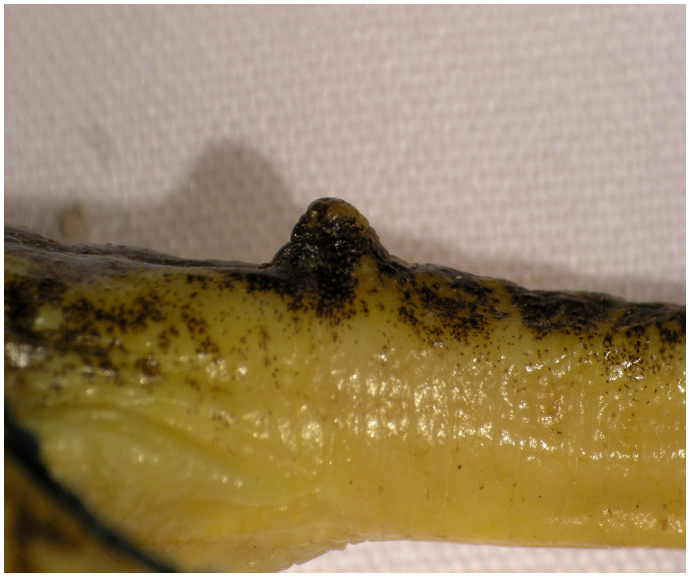

Figure 11. A female specimen (ZMADYU 2012/39-5♀) from Karadere which shows an unusually advanced hedonic protuberance at the base of the tail (1.68 mm).

Similar to the Dodurga site, the habitat near Karadere is under current destruction by humans. Uncontrolled agricultural developments, cutting trees, tourism activities on the historical Lycian way and in particular, the unrestrainedly activities of numerous quarries, are some of the important

threats on this declining of population.

Comparison of the Populations

We compared the populations morphologically (mensural characters, colouration pattern), serologically (blood-serum proteins) and ecologically, respectively. We found significant differences between Dodurga and Karadere population by the Student T test. We compared the males, females, juveniles and adults combined, separately.

According to Student T test (see Table 3), we determined some statistically significant (P≤0.05) differences between males of the Dodurga and Karadere populations in terms of characters from the raw data and ratios (TBL, RA, LT, TL, HL, HW, PL, PW, HLL, HDPBT, HW/HL, PW/PL), and by the PERCRA index values (PW, HDPBT). Comparing of female specimens of the Dodurga and Karadere populations by the raw data and ratios (TBL, RA, LT, TL, HL, HW, FLL, HLL, DFHL, HW/HL), PERCRA index (DBN, HW, FLL, HLL). Comparison of the juveniles from Dodurga and Karadere populations, in raw data and ratios (TL, PW, HLL, TL/TBL, PW/PL), with PERCRA index values (TBL, TL, HW, PW, HLL) are found significant (P≤0.05). Most importantly, adult specimens combined (males+females) of both populations (Dodurga and Karadere) are compared by Stutent T test. As a result, we found significant differences between the population by the raw data and ratios (TBL, RA, LT, TL, ED, HL, HW, PL, PW, FLL, HLL, DFHL, HW/HL, NED/HL), and by the PERCRA index values (DBN, FLL, HLL) (Table 3).

As a result of the serological comparison, we determined 11-12 blood-serum protein fractions which are 9-10 globulin, 2 albumin zone proteins in Dodurga specimens. However, we detected 14 blood-serum protein fractions; 11 globulin, 3 albumin zone proteins in Karadere specimens, respectively. These data show that, two populations are clearly different from each other in terms of blood-serum proteins (see Figure 5 and Figure 9).

At present, the nominate race of Luschan' Lycian Salamander, *Lyciasalamandra luschani luschani* has 8 known populations; 1- Northern part of Babadağ Mountain (Patlangıç district), 2- Kıdrak district, Uzunyurt

Table 3. Comparisons of mensural characters between Dodurga and Karadere populations with P values (significance of T-test). Significantly different values from each other (P≤0.05) are boldfaced. 1: According to the values in raw data; 2: According to the values in PERCRA index. The other abbreviations of the characters are given in Materials and Methods.

Characters		Males	Females	Juveniles	Sum Adults
TBL	1	**0.001**	**0.022**	0.231	**0.005**
	2	0.709	0.270	**0.048**	0.305
RA	1	**0.009**	**0.010**	0.849	**0.002**
LT	1	**0.046**	**0.039**	0.939	**0.015**
	2	0.073	0.228	0.819	0.092
TL	1	**0.041**	**0.050**	**0.043**	**0.019**
	2	0.709	0.270	**0.048**	0.305
NED	1	0.967	0.071	0.520	0.127
	2	0.342	0.267	0.420	0.125
DBN	1	0.388	0.078	0.168	0.272
	2	0.079	**0.024**	0.130	**0.006**
ED	1	0.129	0.070	0.849	**0.017**
	2	0.924	0.137	0.573	0.232
HL	1	**0.000**	**0.000**	0.518	**0.000**
	2	0.073	0.221	0.819	0.089
HW	1	**0.031**	**0.019**	0.123	**0.002**
	2	0.770	**0.048**	**0.013**	0.134
PL	1	**0.001**	0.061	0.924	**0.011**
	2	0.819	0.138	0.827	0.236
PW	1	**0.002**	0.070	**0.012**	**0.005**
	2	**0.032**	0.757	**0.010**	0.650
FLL	1	0.782	**0.037**	0.059	**0.050**
	2	0.143	**0.027**	0.104	**0.010**
HLL	1	**0.000**	**0.002**	**0.009**	**0.000**
	2	0.330	**0.020**	**0.020**	**0.014**
DFHL	1	0.279	**0.046**	0.132	**0.027**
	2	0.436	0.841	0.253	0.439

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Table 3. (Continuing)

Characters		Males	Females	Juveniles	Sum Adults
HDPBT	1	**0.000**			
	2	**0.000**			
HW/HL	1	**0.026**	**0.003**	0.131	**0.000**
TL/TBL	1	0.754	0.286	**0.050**	0.334
PW/PL	1	**0.039**	0.551	**0.003**	0.131
NED/HL	1	0.088	0.066	0.662	**0.011**

village (Ölüdeniz), 3- Pınara mevkii, Minare village, 4- Bozyer village, 5- Boğaziçi village, 6- Dodurga village (*tt*), 7- Belceğiz, Karadere village, 8- Letoon (Akman et al. 2013, Göçmen et al. 2011). Veith et al. 2008 and Akman et al. 2013 stated that first six populations which are mentioned above showed only haplotypes of *L. l. luschani* by the preliminary DNA barcoding using a fragment of the mitochondrial 16S rRNA gene. However, some Lycian salamanders from the Letoon population which are morphologically similar to Karadere specimens were genetically affiliated to the neighboring subspecies *L. l. basoglui* (Mutz 1994, Vetih et al. 2008). Akman et al. 2013 indicated that Bozyer and Minare populations have similar dorsum ground colour, tough they have only *L. l. luschani* haplotypes. Remarkably, some of Karadere specimens also showed *L. l. basoglui* haplotypes by the preliminary DNA barcoding using a fragment of the mitochondrial 16S rRNA gene (M. Veith, pers. comm.-data not shown).

Göçmen et al. 2013 published the first records of *L. l. basoglui* from Çavdır Antalya province, which is almost in contact (6 km distance) with *L. l. luschani* (Letoon) where the Eşen stream constitutes a possible isolating barrier between the two subspecies. This data is supporting and confirming our results.

In conclusion, Dodurga and Karadere populations are compared in terms of electrophoretic studies which were carried out with blood serum proteins, morphometric characters and colour-pattern characters in detail. As a result of our survey, we concluded that the Lycian salamander population in Belceğiz Lycian way, Karadere, Muğla province represents an

intermediate population between *L. l. luschani* and *L. l. basoglui*, likewise Letoon population.

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REFERENCES

Akman, B., Godmann, O. (2014): A new subspecies of *Lyciasalamandra antalyana* (Amphibia: Salamandridae) from the Lycian Coast, Turkey. Salamandra 50(3): 125-132.

Akman, B., Göçmen, B., Veith, M., Oğuz, M.A., Yalçınkaya, D. (2013): New localities of *Lyciasalamandra luschani luschani* (Steindachner, 1891) (Amphibia: Urodela: Salamandridae). Herpetologica Romanica 7: 29-39.

Akman, B., Yalçınkaya, D., Karış, M., Göçmen, B. (2011): Range Extension of *Lyciasalamandra atifi* (Başoğlu, 1967) (Amphibia: Urodela: Salamandridae). North-Western Journal of Zoology 7(2): 360-362.

Arıkan, H. (1983): Ege Bölgesinde Yaşayan *Rana ridibunda* (Anura, Ranidae) Populasyonlarının Serolojik Yönden İncelenmesi. Doğa Bilim Dergisi: Temel Bilimler 7: 37-45.

Baran, İ., Atatür, M.K. (1980): On a New Form of *Mertensiella luschani* (Steindachner) Living in the Vicinity of Kaş (Southwestern Anatolia). Ege Üniversitesi Fen Fakültesi İlmi Raporlar Serisi 248: 1-13.

Başoğlu, M. (1967): On a Third Form of *Mertensiella luschani* (Steindachner) (Amphibia, Salamandridae). Ege Üniversitesi Fen Fakültesi İlmi Raporlar Serisi 44: 1-11.

Başoğlu, M., Atatür, M.K. (1974): The Subspecific Division of the Lycian Salamander, *Mertensiella luschani* (Steindachner) in Southwestern Anatolia. İstanbul Üniversitesi Fen Fakültesi Mecmuası Seri B 39(3-4): 147-155.

Başoğlu, M., Atatür, M.K. (1975): A New Population of the Lycian Salamander, *Mertensiella luschani* (Steindachner) from Finike in Southwestern Anatolia. İstanbul Üniversitesi Fen Fakültesi Mecmuası Seri B 40(1-4): 89-93.

Başoğlu, M., Baran, İ. (1976): The Subspecific Status of the Population of *Mertensiella luschani* (Steindachner) in the Antalya Region of Southwestern Anatolia. Ege Üniversitesi Fen Fakültesi İlmi Raporlar Serisi 235: 1-13.

Boulenger, G. (1892): On newly-discovered East-African Chamaeleons, with Remarks on some other Reptiles described by Dr. Steindachner. Annals and Magazine of Natural History, Ser.6 9: 74.

Davis, B.J. (1964): Disc Electrophoresis. II. Method and Application to Human Serum Proteins. Annals of the New York Academy of Sciences 121: 404-427.

Franzen, M., Klewen, R. (1987): *Mertensiella luschani billae* ssp. n. - Eine Neue Unterart des Lykischen Salamanders aus SW-Anatolien. Salamandra 23: 132-141.

Franzen, M., Steinfartz, S. (1999): *Mertensiella* Wolterstorff, 1925 - Kleinasiatische Salamander. -In: Grossenbacher, K. & B. Thiesmeier (eds.): Handbuch der Reptilien und Amphibien Europas. Band 4/1. Schwanzlurche (Urodela) 1: 323-328.

Göçmen, B., Akman, B. (2012): *Lyciasalamandra arikani* n. sp. & *L. yehudahi* n. sp. (Amphibia: Salamandridae), Two New Lycian Salamanders from Southwestern Anatolia. North-Western Journal of Zoology 8(1): 181-194.

Göçmen, B., Arıkan, H., Yalçınkaya, D. (2011): A New Lycian Salamander, Threatened with Extinction, from the Göynük Canyon (Antalya, Anatolia), *Lyciasalamandra irfani* n. sp. (Urodela: Salamandridae). North-Western Journal of Zoology 7(1): 151-160.

Göçmen, B., Veith, M., Akman, B., Godmann, O., İğci, N., Oğuz, M.A. (2013): New records of the Turkish Lycian salamanders (*Lyciasalamandra*, Salamandridae). North-Western Journal of Zoology 9(2): 319-328.

Mutz, T. (1994): Die Bekannten Fundorte und Neue Funde von *Mertensiella luschani* in der Türkei. Elaphe 2: 51.

Mutz, T., Steinfartz, S. (1995): *Mertensiella luschani flavimembris* ssp. n., Eine Neue Unterart des Lykischen Salamanders aus der Turkei (Caudata: Salamandridae). Salamandra 31: 137-148.

Nikol'skii, A.M. (1918): Fauna of Russia and adjacent countries. Amphibians (English translation, 1962). Off. Tech. Serv., 60-21813, USA.

Öz, M., Düşen, S., Tunç, R., Kumlutaş, Y., Durmuş, H., Kaska, Y. (2004): A Morphological and Taxonomical Study on the Subspecies of the Lycian Salamander, *Mertensiella luschani* (Steindachner, 1891) (Urodela: Salamandridae). Turkish Journal of Zoology 28: 237-244.

Özeti, N. (1967): The Morphology of the Salamander *Mertensiella luschani* (Steindachner) and the Relationships of *Mertensiella* and *Salamandra*. Copeia 2: 287-298.

Özeti, N., Atatür, M.K. (1979): A Preliminary Survey of the Serum-Proteins of a Population of *Mertensiella luschani finikensis* Başoğlu and Atatür from Finike in Sothwestern Anatolia. İstanbul Üniversitesi Fen Fakültesi Mecmuası 44: 23-29.

Pieper, H. (1963): Eine Neue *Mertensiella* - Form von der Griechischen Insel Karpathos (Amphibia: Salamandridae). Senckenbergiana Biologica 44: 441-446.

Steindachner, F. (1891): Über Einige Neue und Seltene Reptilien und Amphibienarten. aus den Sitzungaberichten d. Kais Akademie d. Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Classe 100: 289-314.

Steinfartz, S., Mutz, T. (1999): *Mertensiella luschani* (Steindachner, 1891) – Lykischer Salamander, Kleinasiatischer Salamander - In: Grossenbacher, K. & B. Thiesmeier

(eds.): Handbuch der Reptilien und Amphibien Europas. Band 4/1. Schwanzlurche (Urodela) 1: 367-397.

Üzüm, N., Avcı, A., Bozkurt, E., Olgun, K. (2015): A new subspecies of *Lyciasalamandra flavimembris* (Urodela: Salamandridae) from Muğla, southwestern Turkey. Turkish Journal of Zoology 39: 328-334.

Veith, M., Steinfartz, S. (2004): When Non-monophyly Results in Taxonomic Consequences - the Case of *Mertensiella* within the Salamandridae (Amphibia: Urodela). Salamandra 40: 67-80.

Veith, M., Baran, İ., Godmann, O., Kiefer, A., Öz, M., Tunç, M.R. (2001): A Revision of Population Designation and Geographic Distribution of the Lycian Salamander *Mertensiella luschani* (Steindachner, 1891). Zoology in the Middle East 22: 67-82.

Veith, M., Lipscher, E., Öz, M., Kiefer, A., Baran, İ., Polymeni, R.M., Steinfartz, S. (2008): Cracking the Nut: Geographical Adjacency of Sister Taxa Supports Vicariance in a Polytomic Salamander Clade in the Absence of Node Support. Molecular Phylogenetics and Evolution 47: 916-931.

Waga, A. (1876): Nouvelle espèce de Salamandride. Revue et Magasin de Zoologie Pure et Appliquée, Paris, Sér.3 4: 326-328.

Weisrock, D.W., Macey, J.R., Uğurtaş, İ.H., Larson, A., Papenfuss, T.J. (2001): Molecular Phylogenetics and Historical Biogeography Among Salamandrids of the "True" Salamander Clade: Rapid Branching of Numerous Highly Divergent Lineages in *Mertensiella Luschani* Associated with the Rise of Anatolia. Molecular Phylogenetics and Evolution 18: 434-448.

Werner, F. (1902): Die Reptilien und Amphibien fauna von Kleinasien. Sitzungsberichte der Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe, Abteilung 1: 1057-1121.

Werner, Y.L. (1971): Some Suggestions for the Standard Expression of Measurements. Systematic Zoology 20: 249-252.

Wolterstorff, A. (1925): Katalog der Amphibien - Sammlung im Museum für Natur-und Heimatkunde. Abhandlungender Berlin Museum Natur Heimatkunde, Magdeburg 4: 155-310.

Yıldız, M.Z., Akman, B. (2015): A new subspecies of Atif's Lycian Salamander *Lyciasalamandra atifi* (Başoğlu, 1967), from Alanya (Antalya, Turkey) (Caudata: Salamandridae). Herpetozoa 28 (1/2): 3-13.