

Population ecology and distribution of *Pelophylax caralitanus* (ARIKAN, 1988), in the Lakes District, southwestern Anatolia, Turkey (Anura: Ranidae)

Populationsökologie und Verbreitung von *Pelophylax caralitanus* (ARIKAN, 1988)
im südwestanatolischen Seendistrikt (Türkei)
(Anura: Ranidae)

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KURZFASSUNG

Die Untersuchung präsentiert eine Analyse der morphometrischen und Farbmerkmale bei *Pelophylax caralitanus* (ARIKAN, 1988) von fünf türkischen Fundorten, schätzt die Populationsgrößen und bringt weitere Verbreitungsdaten, die das bekannte Verbreitungsgebiet der Art vergrößern. Weibchen der Art werden größer als Männchen, während morphometrische und Färbungsmerkmale zwischen den Geschlechtern aber auch zwischen den Fundorten/Populationen nicht signifikant variierten. Das bisher bekannte Verbreitungsgebiet von *P. caralitanus* wurde um die Provinz Burdur und zwei darin gefundene Populationen erweitert. Die Populationsgröße ermittelt auf Grundlage einer Rückfang-Methode betrug 5046 Individuen im Gölçük-See, 1198 im Lebensraum bei Beyşehir-Kuşluca und 1211 in einem Teich bei Derebucak. Die Art kam in natürlichen Seen und Teichen aber auch in angelegten Gewässern wie Bewässerungskanälen, Tümpeln und Teichen vor; alle waren sie reichlich bewachsen.

ABSTRACT

This study provides the external features of *Pelophylax caralitanus* (ARIKAN, 1988), sampled in five localities in Turkey, estimates its population sizes and presents new distribution sites extending the known range. *Pelophylax caralitanus* exhibit sexual size dimorphism, females become larger than males. In contrast, morphometric characters and coloration patterns do not differ significantly among sexes or localities/populations. The known distributional range of *P. caralitanus* was extended to the province of Burdur, where two new populations were detected. The sizes of these populations, estimated using the Capture-Marking-Recapture (CMR) method, were 5,046 individuals in Lake Gölçük, 1,198 individuals in the Beyşehir-Kuşluca habitat, and 1,211 individuals in a pond at Derebucak. This species was found in natural lakes and ponds but also artificial irrigation channels, pools and ponds. All these habitats were covered with aquatic vegetation.

KEY WORDS

Amphibia: Anura: Ranidae: *Pelophylax caralitanus*; ecology, population size, distribution, new locality record, Lakes District, Beyşehir, central south Anatolia, Turkey

INTRODUCTION

BODENHEIMER (1944) described water frogs with orange-colored venters from Lake Beyşehir, central south Anatolia, but did not provide detailed information about the specimens, which he classified as *Pelophylax ridibundus ridibundus* (PALLAS, 1771), *Rana ridibunda ridibunda* in his terminology. ARIKAN (1988) was the first to describe this species as a new taxon. He found significant differences to the nominate subspecies of *ridibundus* in morphometric characters, color and pattern of the venter and

described the Beyşehir population as *Rana ridibunda caralitana*. BEERLI et al. (1994), however, claimed that *R. r. caralitana* was not a new subspecies and argued that *R. r. caralitana* and *Rana levantina* SCHNEIDER & SINSCH, 1992, should be regarded synonyms of *Pelophylax bedriagae* (CAMERANO, 1882) (*Rana bedriagae* in their terminology). ALPAGUT & FALAKALI (1995) compared Beyşehir and İzmir specimens using karyologic methods and proposed that *caralitana* should be given the status of a sepa-

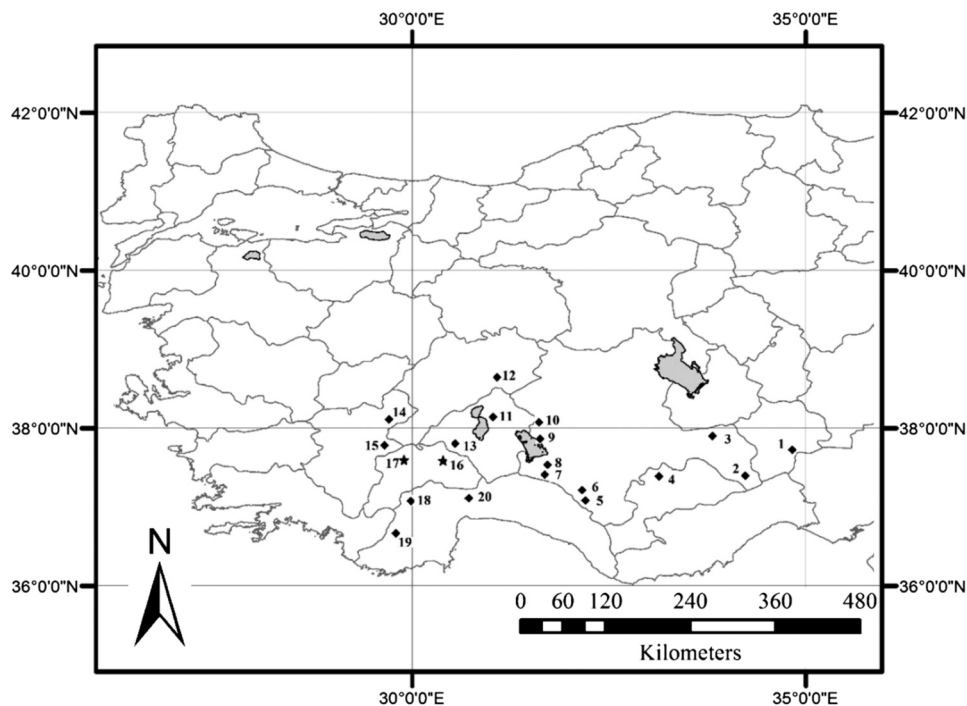


Fig. 1: Currently known distribution of *Pelophylax caralitanus* (ARIKAN, 1988) and the studied sites.

On the map, stars represent new localities and diamonds those previously known.

In the legend, the numbers of studied populations (6, 7, 9, 13, 16, and 17) are written in bold.

Abb.1: Gegenwärtig bekannte Verbreitung von *Pelophylax caralitanus* (ARIKAN, 1988) und Lage der Fundorte.

In der Karte stellen Sterne die beiden neuen und Rhomben die zuvor bekannten Fundorte dar.

Die Nummern der untersuchten Populationen (6, 7, 9, 13, 16, 17) sind nachstehend in Fettschrift gesetzt.

1 - Bor/Niğde; 2 - İvriz/Ereğli/Konya; 3 - Yağmapınar/Karapınar/Konya; 4 - Lake of Hotamış/Konya; 5 - Tınaztepe/Seydişehir/Konya; 6 - Lake of Suğla/Konya; 7 - Derebucak/Konya; 8 - Lake of Gencek/Derebucak/Konya; 9 - Akburun and Kuşluca populations/Lake of Beyşehir/Konya [terra typica of *Pelophylax caralitanus* (ARIKAN, 1988)]; 10 - Fele/Şarkıkarağaç/Isparta; 11 - Lake of Eğirdir/Isparta; 12 - Eber/Lake of Konya; 13 - Gölcük/Lake of Isparta; 14 - Lake of Işıklı/Denizli; 15 - Acıgöl/Denizli;

16 - Ağlasun/Burdur (new locality); **17** - Yazıköy/Burdur (new locality);

18 - Taşkesiği/Korkuteli/Antalya; 19 - Girdev Plateau/Elmalı/Antalya; 20 - Kırkgöz/Antalya.

rate taxon. Subsequent morphological, genetic and bioacoustic studies of the Beyşehir population revealed that *caralitanus* differed considerably from *ridibundus* (ARIKAN et al. 1994, 1998; BUDAK et al. 2000; JDEIDI 2000; JDEIDI et al. 2001; PLÖTNER et al. 2001; KAYA et al. 2002). Thus, *caralitanus* was raised to species level (JDEIDI 2000; JDEIDI et al. 2001; PLÖTNER et al. 2001).

Studies conducted on this new species showed that *Pelophylax caralitanus* inhabits the Lakes of Eğirdir and Suğla, and the Çarşamba River and its channels in the

Lakes District (ATATÜR et al. 1990). Later, ARIKAN et al. (1994) found *P. caralitanus* also in the lakes of Gölcük (Isparta) in western Anatolia, Hotamış in eastern Anatolia, and in water bodies at the foothills of the Taurus Mountains in southern Anatolia. The known range of *P. caralitanus* was further extended in recent years (ATATÜR et al. 1990; ARIKAN et al. 1994, 1998; BUDAK et al. 2000; KAYA et al. 2002; DÜŞEN et al. 2004; TOSUNOĞLU et al. 2005; AYAZ et al. 2007) resulting in the view that *P. caralitanus* is endemic to the Lakes District and its close vicinity in Anatolia (Turkey).

Pelophylax caralitanus is listed as Near Threatened (NT) because of ongoing habitat loss and overexploitation (IUCN 2016). This comparatively low rating was based on its relatively wide distribution, presumed large populations and the unlikeliness to decline fast enough to qualify for listing in a higher Red List category. Continued exploitation for trade, however, could threaten this species in the future.

This paper evaluates the significance of distinctive external features of *P. caralitanus* and presents new distribution sites, extending its known range. Moreover, estimates based on the Capture-Mark-Recapture (CMR) technique are presented of the annual population sizes, survival rates and capture probabilities in three populations of *P. caralitanus*. Also, the habitat features of this species are specified more precisely.

MATERIALS AND METHODS

Study sites

The morphometric studies analyzed specimens from the newly discovered Ağlasun and Yazıköy populations and previously known Gölcük, Suğla Lake and Akburun populations. Population size was estimated in the Gölcük, Kuşluca and Derebucak Ponds. The known distribution of *P. caralitanus* and the study sites are shown in Fig. 1.

Ağlasun population.— The aquatic habitat (37°36'N, 30°32'E; 1,013 m a.s.l.) is located in the village of Kibrit, municipality of Ağlasun, district of Burdur. Specimens were collected from a quarry area belonging to a brick factory where several water bodies (surface area 52 ha, depth 2 m) filled with rain- and underground water had developed after excavation of clay soil. The periphery and water surface of these ponds had covered by aquatic vegetation (*Myriophyllum spicatum* and *Cladophora* sp.) within a few years. This area is private property and closed to the public.

Yazıköy population.— The aquatic habitat (37°38'N, 30°03'E; 859 m a.s.l.) is located between the villages of Yazıköy and Kumluca, district of Burdur. The small wetland area is surrounded by agricultural land and connected with Lake Burdur by a channel. The periphery and the surface of the water body (surface area 155 ha, depth 2 m) are covered with aquatic vegetation. This permanent aquatic site represents a natural amphibian habitat that is fed by underground water sources and rain. Agricultural activities, water extraction from the channel for irrigation purposes and amateur fishing characterize this site and its surroundings.

Akburun and Kuşluca populations.— The aquatic habitats of these populations (village of Akburun: 37°46'N, 31°36'E; 1,126 m a.s.l.; village of Kuşluca: 37°50'N, 31°34'E; 1,127 m a.s.l.) are the shores of Lake Beyşehir in the province of Konya, type locality of *P. caralitanus*. Lake Beyşehir is the second largest lake in Turkey, its surface area is 65,600 ha and its maximum depth is 10 m. The shores at the study areas Akburun and Kuşluca cover 15 ha and 80 ha, respectively, with shallow water up to 3 m deep. Residential areas (Akburun and Kuşluca) and farmland are located close to both populations. In early spring, the coastal areas become inundated as water levels rise due to rainfall which creates spawning sites.

Suğla Lake population.— The lake (surface area 3,740 ha, depth 2 m) (province of Konya, 37°21'N, 32°01'E; 1,213 m a.s.l.) is connected to irrigation channels and fed by underground water sources, creeks and melting water. Most of the coastal area is covered with reed and willow trees, minor parts are bordered by big stones and a concrete wall.

Derebucak Pond population.— The artificial water body (surface area less than 1 ha, depth 0.5 m) in the vicinity of the village of Derebucak, province of Konya (37°22'N, 31°31'E; 1,226 m a.s.l.) is fed by underground water sources, a creek and melting water. The population of this locality is closed which is why it was used to estimate its size.

Gölcük Lake population.— The lake (surface area 81 ha, depth 30 m) in the province of Isparta (37°43'N, 30°29'E; 1,387 m a.s.l.) is surrounded by coniferous trees (*Pinus brutia*), willows (*Salix alba*) and reed

Table 1: Descriptive statistics of the studied morphometric parameters of male and female *Pelophylax caralitanus* (ARIKAN, 1988), and results of the independent t test. Measurements as defined in TERENTJEV & CHERNOV (1965). SVL – Snout Vent Length, HL – Head Length, HW – Head Width, TL – Tibia Length, FTL – First Toe Length, MTL – Metatarsal Tubercle Length, N – Sample size.

Tab. 1: Deskriptive Statistiken der untersuchten morphometrischen Parameter männlicher und weiblicher *Pelophylax caralitanus* (ARIKAN, 1988) sowie t-Test Ergebnisse. Meßstreckendefinitionen nach TERENTJEV & CHERNOV (1965). SVL – Kopf-Rumpf-Länge, HL – Kopfgröße, HW – Kopfbreite, TL – Tibialänge, FTL – Länge der ersten Zehe, MTL – Länge des Metatarsaltuberkels, N – Stichprobenumfang.

Parameter	Sex	N	Mean (mm) Mittelwert	Std. Error (mm) Standardfehler	t	df	P
SVL	Male	60	75.83	0.772	-5.759	114	0.000
	Female	56	82.56	0.882			
TL	Male	60	38.59	0.615	-4.594	114	0.000
	Female	56	43.14	0.788			
HL	Male	60	25.06	0.273	-6.153	114	0.000
	Female	56	27.52	0.293			
HW	Male	60	28.18	0.286	-5.814	114	0.000
	Female	56	30.69	0.326			
FTL	Male	60	15.53	0.513	-9.678	114	0.000
	Female	56	26.35	1.019			
MTL	Male	60	4.33	0.064	-5.802	114	0.000
	Female	56	4.81	0.051			

(*Phragmites australis*), the water surface is covered with *Myriophyllum spicatum*. This permanent, natural amphibian habitat is fed by underground water sources and rain; it belongs to a protected Natural Park. At this locality both population size estimation and morphometric analyses were done.

Field studies and morphometric measurements

Field studies were conducted during the breeding seasons (late April to early August) 2010-2014. *Pelophylax caralitanus* individuals were captured by two- or three-person teams with a dip net or by hand after sunset using flashlights. The frogs were kept in a plastic container until marking by digital photography and measurements were completed, and thereafter released to the places where they were collected. Sex, dates and image numbers for all individuals were recorded. The frogs were individually recognized by their dorsal pattern. To minimize the probability of misidentification, the congruence of images and individuals was verified by at least two persons; all of the dorsal pattern was screened to ensure correct identification.

Apart from the frogs which entered the CMC study, a total of 116 specimens (60

females and 56 males) were captured for morphological analysis (Table 1). The morphometric measurements were done with a dial caliper at 0.02 mm accuracy. Measurements and the color pattern information (maculation and presence or absence of vertebral stripes) were taken from adult frogs only. According to TARKHNISHVILI & GOKHELASHVILI (1999) and ERIŞİMİŞ & CHINSAMY (2010), individuals exceeding snout-vent-lengths of 60 and 65 mm were considered adult males and females, respectively. The following measurements were made as defined in TERENTJEV & CHERNOV (1965): Snout Vent Length (SVL), Head Length (HL), Head Width (HW), Tibia Length (TL), First Toe Length (FTL) and Metatarsal Tubercle Length (MTL).

Statistical analyses

The measurement data revealed normal distribution (Kolmogorov-Smirnov D test, all $P > 0.05$), thus allowing comparisons using parametric tests. Morphometric comparison of the sexes was done using an independent samples t test. To detect morphometric differences between populations, a one-way ANOVA test was applied. Discriminant function analysis was used to predict population membership of the spec-

imens. Chi-square (χ^2) tests were employed to compare the ratio of females and males among different localities. To determine the deviation from a 1:1 sex ratio, a binominal test was used; P values ≤ 0.05 were considered statistically significant. All statistical analyses were computed with SPSS ver. 20.0.

To estimate the annual population size, Closed Capture Models under the program Mark ver. 5.1 (COOCH & WHITE 2016) were used. This program regards the variation of the detection rate in closed populations, from a total of eight different models, including the null hypothesis, and also

includes the appropriate model selection according to OTIS et al. (1978). The selection of the appropriate model, the number of the simulated data sets, the combination of the χ^2 test and the procedures executed in the program Mark are based on the regression approach. Annual capture probabilities and survival rates were estimated using the Cormack-Jolly-Seber method [Model $\Phi(.)$ $p(.)$; where survival and capture probability is equal for both sexes and constant over time] under the program Mark. This model is a conjugate model of M0 according to OTIS et al. (1978) under the program Mark (COOCH & WHITE 2016).

RESULTS AND DISCUSSION

Pelophylax caralitanus inhabited permanent natural or artificial water bodies at the study sites and showed feeding, reproduction and sheltering behaviors both during the night and day. Individuals were frequently observed in lakes, with aquatic vegetation generally covering the water surface of the shoreline. The shorelines of the lakes were characterized by reed belts and, at intervals, rotted *Salix* sp. and broken branches of these trees floating on the water surface. The species was also found in or near artificial water bodies such as irrigation channels, pools and ponds, where they were noted spawning. These anthropogenic habitats, covered by aquatic vegetation, were constructed to provide drinking water for grazing animals and to irrigate agricultural areas.

The ground colors of the dorsum of the Yazıköy and Ağlasun specimens were greenish-brown or green with varied colored spots. The presence of the vertebral stripe varied among these localities; seven of 24 captured specimens (three females, four males) had vertebral stripes in Yazıköy (29.2 %), while nine of 23 captured specimens (three females, six males) had vertebral stripes in Ağlasun (39.1 %). The ventral coloration, including the extremities and the underside of the head, was off-white covered with orange vermiculate maculations; they were extensive in two male and three female frogs in Yazıköy and one male and four females in Ağlasun. The remaining

frogs had fragmented vermiculate maculations and small spots in both populations.

In dorsal and ventral coloration, the water frogs of the previously known localities Suğla, Akburun and Gölcük, resembled the new records at Yazıköy and Ağlasun. Two males and one female in Suğla, one male and three females in Akburun, and two males and two females in Gölcük had an extensive vermiculate underside whereas, the remaining specimens in these populations had less vermiculate maculations and small spots. A dorsal stripe was present in seven individuals (three females, four males) in Suğla (33.3 %), eight (five females, three males) in Akburun (32 %) and five (three females, two males) in Gölcük (21.8 %).

The species exhibited sexual dimorphism in size: females were significantly larger than males (Table 1). Male and female measurements were not pooled because of significant sex-related differences in several morphometric parameters (Table 1). Morphometric differences relative to different localities were investigated separately for each sex. One-way ANOVA did not detect statistically significant differences in morphometric characters for individuals collected from different localities (Table 2). Discriminant analyses of the morphometric data resulted in four significant discriminant functions (the first explaining 49.9 % of the total variance - Table 3A), and correctly assigned 29.3 % of

Table 2: Descriptive statistics of the studied morphometric parameters of male and female *Pelophylax caraltianus* (ARIKAN, 1988) indicated per site (lengths in mm), and results of the one-way ANOVA. Std. Error - Standard Error of the Mean; for character abbreviations see Table 1.

Tab. 2: Deskriptive Statistiken der untersuchten morphometrischen Parameter männlicher und weiblicher *Pelophylax caraltianus* (ARIKAN, 1988), angegeben für jeden Fundort (Längenangaben in mm) und ANOVA-Ergebnisse. Mean - Mittelwert; Std. Error - Standardfehler des Mittelwertes; Merkmalsabkürzungen siehe Tab. 1.

Character / Merkmal	Locality Fundort	Males / Männchen					Females / Weibchen				
		N	Mean	Std. Error	Min.	Max.	N	Mean	Std. Error	Min.	Max.
SVL	Suğla	11	76.28	1.771	69.58	86.12	10	81.08	2.595	71.56	96.98
	Akburun	14	77.93	1.735	67.78	88.54	11	82.42	2.144	72.88	92.88
	Göleük	12	75.8	1.602	66.62	82.7	11	83.38	1.913	74.42	91.16
	Yazıköy	12	74.41	1.495	67.14	86.66	12	82.66	1.548	72.56	90.88
	Ağlasun	11	74.3	2.067	63.54	84.44	12	83.06	2.008	71.66	92.54
TL	Suğla	11	39.88	2.676	34	65.62	10	42.23	2.308	35.12	57.78
	Akburun	14	39.33	0.777	34.64	45.36	11	41.21	1.552	35.22	50.16
	Göleük	12	38.99	0.943	35.26	46.22	11	43.2	1.161	38.6	50.22
	Yazıköy	12	36.92	0.878	32.04	43.36	12	44.04	1.469	38.28	52.32
	Ağlasun	11	37.71	1.172	32.18	43.96	12	44.72	2.213	35.62	61.5
HL	Suğla	11	25.51	0.454	23.56	28.8	10	27.13	0.85	22.96	31.26
	Akburun	14	25.84	0.621	22.9	29.74	11	27.67	0.686	24.52	31.62
	Göleük	12	24.86	0.575	22.62	28	11	27.74	0.668	24.12	30.65
	Yazıköy	12	24.36	0.567	21.68	27.54	12	27.41	0.531	23.44	30.54
	Ağlasun	11	24.6	0.771	21.26	28.24	12	27.62	0.665	23.1	30.58
HW	Suğla	11	28.34	0.663	25.62	31.78	10	30.07	0.964	26.6	35.98
	Akburun	14	28.96	0.645	25.22	32.9	11	30.66	0.786	27.08	34.52
	Göleük	12	28.11	0.6	24.74	30.72	11	31.02	0.718	27.66	33.88
	Yazıköy	12	27.69	0.55	24.95	32.2	12	30.72	0.578	26.96	33.8
	Ağlasun	11	27.64	0.755	23.88	31.36	12	30.91	0.729	26.6	34.38
FTL	Suğla	11	16.55	1.576	12.42	31.26	10	27.03	2.471	14.56	35.72
	Akburun	14	16.54	1.306	12.1	32.42	11	27	2.502	15.08	36.84
	Göleük	12	15.52	1.375	12.26	30.08	11	26.7	2.418	15.36	35.6
	Yazıköy	12	14.18	0.353	12.76	16.72	12	26.84	2.164	16.06	35.62
	Ağlasun	11	14.71	0.484	12.44	18.56	12	24.38	2.2	15.2	34.78
MTL	Suğla	11	4.4	0.192	3.62	5.82	10	4.75	0.118	4.24	5.42
	Akburun	14	4.48	0.136	3.56	5.46	11	4.88	0.14	4.22	5.62
	Göleük	12	4.29	0.116	3.68	5.02	11	4.81	0.16	4.16	5.32
	Yazıköy	12	4.18	0.111	3.7	5.04	12	4.78	0.095	4.06	5.26
	Ağlasun	11	4.28	0.165	3.7	5.72	12	4.84	0.12	4.02	5.42

Table 2 (continued). / Tab. 2 (Fortsetzung).

Character / Merkmal	Locality / Fundort	N	Males / Männchen				F	df	P	Females / Weibchen				F	df	P
			Mean	Std. Error	Min.	Max.				Mean	Std. Error	Min.	Max.			
SVL/TL	Suğla	11	1.97	0.102	1.09	2.53	0.314	4	0.868	1.96	0.090	1.41	2.33	0.539	4	0.708
	Akburun	14	1.98	0.018	1.89	2.10				2.02	0.079	1.67	2.53			
	Göleük	12	1.95	0.028	1.77	2.10				1.94	0.048	1.73	2.20			
	Yazıköy	12	2.02	0.019	1.88	2.10				1.90	0.062	1.54	2.23			
SVL/HL	Ağlasun	11	1.97	0.018	1.89	2.10				1.89	0.079	1.50	2.38			
	Suğla	11	2.99	0.097	2.42	3.53	0.204	4	0.935	2.99	0.178	2.36	4.22	0.066	4	0.992
	Akburun	14	3.07	0.089	2.68	3.86				3.02	0.088	2.53	3.54			
	Göleük	12	3.03	0.097	2.38	3.60				3.01	0.063	2.70	3.31			
SVL/FTL	Yazıköy	12	3.07	0.111	2.62	3.79				3.05	0.063	2.66	3.36			
	Ağlasun	10	3.13	0.171	2.27	3.89				3.05	0.109	2.50	3.63			
	Suğla	11	4.84	0.253	2.72	5.60	0.764	4	0.553	3.26	0.341	2.46	4.91	0.296	4	0.879
	Akburun	14	4.90	0.202	2.73	5.60				3.35	0.337	2.45	4.91			
SVL/MTL	Göleük	12	5.10	0.240	2.71	5.63				3.43	0.352	2.50	4.91			
	Yazıköy	12	5.27	0.098	4.73	5.60				3.35	0.315	2.52	4.91			
	Ağlasun	11	5.07	0.114	4.55	5.60				3.73	0.338	2.52	4.91			
	Suğla	11	17.52	0.505	14.80	19.33	0.176	4	0.950	17.08	0.296	14.66	17.89	0.497	4	0.738
HL/HW	Akburun	14	17.49	0.363	15.05	19.33				16.95	0.384	13.22	17.89			
	Göleük	12	17.73	0.349	15.90	19.33				17.35	0.114	17.02	17.96			
	Yazıköy	12	17.86	0.382	15.69	19.33				17.31	0.110	16.89	17.89			
	Ağlasun	11	17.48	0.451	14.76	19.33				17.17	0.162	15.70	17.89			
TL/MTL	Suğla	11	0.90	0.008	0.83	0.92	0.559	4	0.693	0.90	0.012	0.86	1.00	0.485	4	0.747
	Akburun	14	0.89	0.009	0.83	0.92				0.90	0.006	0.87	0.94			
	Göleük	12	0.88	0.011	0.83	0.92				0.89	0.006	0.87	0.92			
	Yazıköy	12	0.88	0.013	0.82	0.93				0.89	0.006	0.87	0.92			
FTL/MTL	Ağlasun	11	0.89	0.012	0.80	0.92				0.89	0.007	0.87	0.94			
	Suğla	11	9.32	0.910	5.85	17.74	0.252	4	0.907	8.89	0.438	7.33	12.35	0.682	4	0.608
	Akburun	14	8.84	0.206	7.53	10.08				8.52	0.411	6.33	10.66			
	Göleük	12	9.12	0.190	7.93	10.13				9.01	0.226	7.99	10.22			
FTL/MTL	Yazıköy	12	8.86	0.213	7.49	9.67				9.24	0.317	8.01	11.23			
	Ağlasun	11	8.86	0.225	7.56	10.04				9.24	0.390	7.25	11.35			
	Suğla	11	3.75	0.287	3.27	6.59	0.504	4	0.733	5.70	0.503	2.98	6.94	0.265	4	0.899
	Akburun	14	3.66	0.216	3.28	6.46				5.57	0.517	2.95	7.05			
FTL/MTL	Göleük	12	3.60	0.276	2.86	6.59				5.56	0.489	3.49	6.81			
	Yazıköy	12	3.39	0.033	3.27	3.70				5.62	0.439	3.44	6.77			
FTL/MTL	Ağlasun	11	3.45	0.045	3.24	3.72				5.08	0.481	3.31	6.77			

Table 3: Discriminant Function Analysis of the morphometric data of *Pelophylax caralitanus* (ARIKAN, 1988) from all study materials and localities: A – Statistics of the canonical discriminant functions 1 to 4; B – Predicted group memberships relative to record localities.

Tab. 3: Diskriminanzanalyse der morphometrischen Daten des gesamten Untersuchungsmaterials von *Pelophylax caralitanus* (ARIKAN, 1988) aus allen Fundorten. A – Kenngrößen der Diskriminanzfunktionen 1 bis 4. B – Prognostizierte Gruppenzugehörigkeit zu Fundortpopulationen.

A	Eigenvalues			Wilks' Lambda			
	Eigenvalue	% of Variance	Canon. Correlation	Wilks' Lambda	χ^2	df	P
1	0.051	49.9	0.220	0.905	10.949	24	0.989
2	0.032	31.3	0.176	0.951	5.522	15	0.987
3	0.016	15.4	0.124	0.981	2.088	8	0.978
4	0.004	3.5	0.059	0.996	0.387	3	0.943

B Predicted Group Membership / Prognostizierte Gruppenzugehörigkeit zu Fundortpopulationen						
Group / Gruppe	Suğla	Akburun	Gölcük	Yazıköy	Ağlasun	Total
Suğla	8; 38.1 %	3; 14.3 %	3; 14.3 %	4; 19.0 %	3; 14.3 %	21; 100 %
Akburun	7; 28.0 %	8; 32.0 %	2; 8.0 %	5; 20.0 %	3; 12.0 %	25; 100 %
Gölcük	5; 21.7 %	3; 13.0 %	4; 17.4 %	6; 26.1 %	5; 21.7 %	23; 100 %
Yazıköy	4; 16.7 %	2; 8.3 %	3; 12.5 %	10; 41.7 %	5; 20.8 %	24; 100 %
Ağlasun	6; 26.1 %	5; 21.7 %	2; 8.7 %	6; 26.1 %	4; 17.4 %	23; 100 %

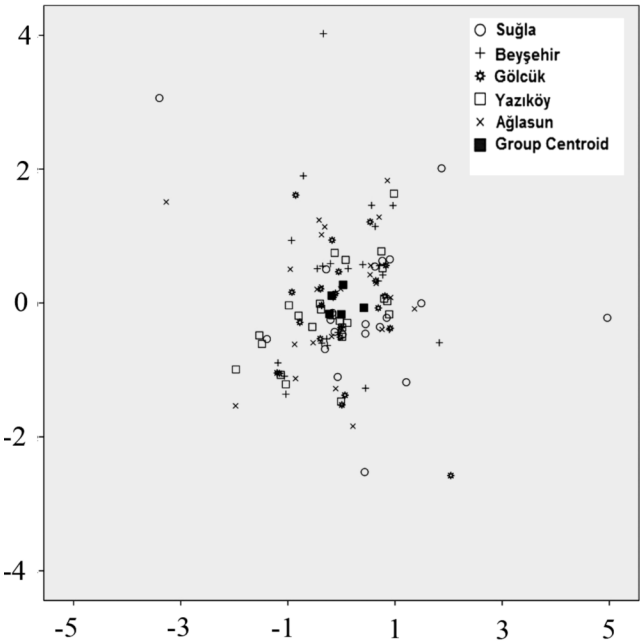


Fig. 2: Territorial map based on the canonical discriminant functions 1 (x axis) and 2 (y axis) derived from the morphometric characters taken from 116 specimens of *Pelophylax caralitanus* (ARIKAN, 1988) of five populations studied. Group centroids are indicated by filled square.

Abb. 2: Territorialkarte auf Grundlage der kanonischen Diskriminanzfunktionen 1 (x-Achse) und 2 (y-Achse) aus den morphometrischen Merkmalen von 116 Exemplaren von *Pelophylax caralitanus* (ARIKAN, 1988) der fünf untersuchten Populationen. Gruppenzentroide sind durch gefüllte Quadrate symbolisiert.

Table 4: Sampling dates of *Pelophylax caralitanus* (ARIKAN, 1988). Summary of the capture history and population sizes at the Gölcük, Beyşehir-Kuşluca and Derebucak localities. Estimates of annual survival rate (ϕ) and capture (p) probability are made under the Model $\phi(\cdot)p(\cdot)$ using the Comarck-Joly-Seber method.

Tab. 4: Sammeldaten von *Pelophylax caralitanus* (ARIKAN, 1988). Zusammenfassung der Fanghistorie und der Populationsgrößen an den Fundorten Gölcük, Beyşehir-Kuşluca und Derebucak. Die Schätzwerte der jährlichen Fangwahrscheinlichkeit (p) und Überlebensrate (ϕ) basieren auf dem $\phi(\cdot)p(\cdot)$ Modell unter Anwendung der Comarck-Joly-Seber Methode.

Locality / Fundortpopulation	Gölcük 2011			Beyşehir-Kuşluca 2012				Derebucak 2012	
Sampling Dates / Sammeltag	12.06.	18.06.	24.06.	17.06.	19.06.	21.06.	29.06.	16.06.	20.06.
Total number of captured individuals / Gesamtzahl gefangener Individuen	338	316	303	123	113	138	134	192	233
Number of newly caught individuals / Anzahl erstmals gefangener Individuen	338	247	275	123	94	104	112	192	168
Number of recaptured individuals / Anzahl wiedergefangener Individuen	0	69	28	0	19	34	22	0	65
Population size / Populationsgröße		5046 \pm 428.3			1198 \pm 114.7				1211 \pm 67.26
95 % confidence interval of population size / 95 % Konfidenzintervall der Populationsgröße		4294 - 5979			1005 - 1458				1093 - 1357
Annual capture probability / jährliche Fangwahrscheinlichkeit		0.12 \pm 0.024			0.30 \pm 0.064				0.34 \pm 0.043
Survival rate / Überlebensrate		0.66 \pm 0.085			0.52 \pm 0.075				0.64 \pm 0.054

the individuals to their original population, although similarity was conspicuous between individuals of different localities (Fig. 2; Table 3B).

The CMR method yielded sufficient information to calculate the population sizes, capture probabilities and survival rates of the populations at Lake Gölcük, Kuşluca at Lake Beyşehir, and in the pond of Derebucak. About 25 % of the individuals of each population were captured per sampling day and almost 61 % of individuals survived a particular year. The results and capture histories are given in Table 4.

The sex ratios (female : male) at these localities were 1.38 (Lake Gölcük), 1.32 (Kuşluca at Lake Beyşehir), and 1.13 (Derebucak Pond). Although the females were more abundant in all three study localities, this difference was not significant ($\chi^2 = 1.196$; $df = 2$; $P > 0.05$). The population sizes, survival rates and annual capture probabilities at these localities are shown in Table 4.

In full agreement with earlier observations, *Pelophylax caralitanus* is a largely aquatic species. It inhabits permanent water bodies with rich aquatic vegetation, including lakes, ponds, rain pools, streams, rivers, irrigation channels, reservoirs, marshes, springs and fishponds (BAŞOĞLU et al. 1994). Inhabiting the wide range of the Turkish Lakes District, this highly opportunistic species proves to be able to adapt to life in modified habitats where suitable wetlands exist, just like the other water frogs in Turkey (BARAN & ATATÜRK 1994; BAŞOĞLU et al. 1994; BARAN et al. 2012).

Adult *P. caralitanus* can be distinguished easily from *P. ridibundus* or *P. bedriagae* by their orange colored venters. Various studies (HOFFMAN & BLOUIN 2000; SUMMERS et al. 2003; AKIN et al. 2010) pointed to the fact that the development of the ventral color maculation is unidirectionally correlated with age: the pale or inconspicuous orange spots in juveniles become prominent and darker in adult *P. caralitanus*. KAYA et al. (2002) stated that the white ventered juveniles of *P. caralitanus* in the Tinaztepe population (Konya) remain inconspicuous, eluding identification and thus, deserve increased research attention. Accordingly, colorpattern characters alone

are not enough to distinguish juvenile individuals of *P. caralitanus* from juveniles of other *Pelophylax* species, such as *P. bedriagae* and *P. ridibundus*. Further investigations defining molecular markers are required.

The pattern and coloration characteristics of the recently detected Ağlasun and Yazıköy populations are almost identical with those reported in previous studies on *P. caralitanus* (ARIKAN 1988; ATATÜR et al. 1990; ARIKAN et al. 1994, 1998; BUDAK et al. 2000; KAYA et al. 2002; DÜŞEN et al. 2004; TOSUNOĞLU et al. 2005; AYAZ et al. 2007). Female *P. caralitanus* attain significantly larger size than males, as is the case in about 90 % of anuran species (SHINE 1979).

The morphometric homogeneity of the studied samples was shown by both univariate and discriminant function analyses. Univariate analyses revealed that the frogs' morphometric characters did not vary significantly between female and male individuals, respectively. Discriminant analysis

correctly assigned only about 30 percent of individuals to their original population, suggesting that the individuals were so similar in shape and body proportions that they were not clearly discriminated by the characters measured. This characterizes *P. caralitanus* as morphologically homogeneous. From the above, it is clear that the newly detected populations belong to *P. caralitanus* and that its range area can be extended to southwestern Anatolia including the province of Burdur.

Knowledge on the size of Turkish ranid populations refers to *P. ridibundus*, *P. bedriagae*, *Rana macrocnemis* BOULENGER, 1885, *Rana holtzi* WERNER, 1898, and *Rana tavasensis* (BARAN & ATATÜR, 1986) (BARAN et al. 2001; KAYA & ERIŞİMİŞ 2001; AYAZ et al. 2007; KAYA et al. 2010; ÇİÇEK et al. 2011; BAŞKALE & KAYA 2012; ÇAPAR & BAŞKALE 2016), and, by the present paper, was extended to *P. caralitanus*, which had remained unknown in this respect.

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