

## New data on the distribution of the Taurus Frog *Rana holtzi* WERNER, 1898, in the Bolkar Mountains of Turkey (Anura: Ranidae)

Neue Angaben zur Verbreitung von *Rana holtzi* WERNER, 1898  
im Bolkar Gebirge (mittlerer Taurus, Türkei)  
(Anura: Ranidae)

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### KURZFASSUNG

Der Türkische Frosch, *Rana holtzi* WERNER, 1898 ist ein seltener Lokalendemit des Bolkar-Gebirges im Taurus Massiv (Türkei), wo sein bekanntes Vorkommen auf nur drei Stellen (Karagöl, Çiniligöl and Eğrigöl) in den Provinzen Niğde und Mersin beschränkt war. In der vorliegenden Untersuchung berichten wir von einem weiteren Fundort von *R. holtzi*, Karagöl (Çamlıyayla/Mersin). Die artliche Zuordnung der Neunachweise erfolgte nach morphometrischen Merkmalen und Eigenarten in Färbung und Zeichnung. Das bekannte Verbreitungsgebiet von *R. holtzi* im Bolkar-Gebirge wird durch die vorliegenden Beobachtungen um etwa 10 km nach Südwesten erweitert.

### ABSTRACT

The Taurus Frog, *Rana holtzi* WERNER, 1898, is a rare local endemic of the Bolkar Mountains, in the Taurus Range (Turkey), where its known distribution was limited to only three localities (Karagöl, Çiniligöl and Eğrigöl) in the provinces of Niğde and Mersin. In this study, we report a new record locality for *R. holtzi*, Karagöl (Çamlıyayla/Mersin), based on morphometrics and pattern/coloration characteristics. Thus, the known distribution range of *R. holtzi* in the Bolkar Mountains was extended by about 10 kilometers into a southwestern direction.

### KEY WORDS

Amphibia: Anura: Ranidae, *Rana holtzi*, Taurus Frog, new record locality, distribution, Karagöl (Çamlıyayla/Mersin), Bolkar Mountains, Taurus Range, Turkey

### INTRODUCTION

The Taurus frog, *Rana holtzi* WERNER, 1898, is a brown frog species closely related to *R. macrocnemis* BOULENGER, 1885 (VEITH et al. 2003a, 2003b). It is endemic to the Bolkar Mountains, in the Taurus Range, southern Turkey and recorded from three localities, Lake Karagöl (formerly Maden Lake, 2500 m a.s.l.), Lake Çiniligöl (2600 m a.s.l.), and Lake Eğrigöl (2750 m a.s.l.) (BARAN et al. 2007). *Rana holtzi* is exclusively observed at high montane lakes with grassy borders and slow-flowing creeks created by snow water. The frogs are also found in meadows, close to the water bodies in which they breed. The creeks are surrounded by dry prairies where domestic sheep graze. In contrast, *R. macrocnemis* is mainly

found in humid areas including broadleaved, mixed and coniferous forests, swamps, steppes, subalpine and alpine meadows. In the Bolkar Mountains, its populations generally occur at somewhat lower elevations such as Gümüş Lake (1945 m a.s.l.), Örtülü village (1460 m a.s.l.) and Seviçova (~2500 m a.s.l.).

*Rana holtzi* has been on the IUCN Red List of Threatened Species and categorized as an Endangered (EN) species since 1996. Restricted geographic distribution and declining population size resulted in this frog's classification as Critically Endangered (CR) in the IUCN Red List in 2008 (OLGUN et al. 2008). The species is also listed on Appendix II of the Berne Convention and is protected by national legislation.

The objective of this study was to (i) summarize information on the taxonomical status of *R. holtzi*, (ii) report the discovery of

a new record locality, and (iii) describe the external morphological features of the frogs found there, in light of previous findings.

## MATERIALS AND METHODS

Field studies were performed by five researchers for periods of two days per month from June to October 2009. Hypothetically suited sites for *R. holtzi* in the Bolkar Mountains were pre-selected using topographic maps, Google Earth<sup>®</sup>, and personal knowledge and observations of local people, and the distinguished herpetologist Prof. Dr. İbrahim BARAN.

For the present study, materials were collected solely from the Lake of Karagöl-Çamlıyayla (37°15'N; 34°20'E; 2678 m a.s.l.). To identify the five new specimens described here [ZDEU 130/2009-1 ♂-4 ♀♀. Karagöl/Mersin. 18.07.2009], *R. holtzi* and *R. macrocnemis* comparative samples from the Zoology Museum of Ege University, (ZDEU) were studied. They were collected from Karagöl-Niğde (type locality of *R. holtzi*) [ZDEU 143/1996-4 ♂♂-8 ♀♀. Karagöl/Niğde. 09.07.1996], Eğrigöl-Çamlıyayla (*R. holtzi* - BARAN et al. 2007) [ZDEU 14/1999-4 ♂♂-7 ♀♀. Eğrigöl/Çamlıyayla. 09.07.1999], Seviçova-Ereğli (*R. macrocnemis* - BARAN et al. 2007) [ZDEU 15/1999-8 ♂♂-8 ♀♀. Seviçova/Ereğli. 09.07.1999] and Uludağ-Bursa (type locality of *R. macrocnemis*) [ZDEU 774/1965-4 ♂♂-8 ♀♀. Uludağ/Bursa. 23-24.06.1965]. All morphometric measurements were made by one member of the study group, from preserved specimens. Pattern and coloration characteristics were taken from the freshly

caught specimens in Karagöl-Çamlıyayla and evaluated by comparison with preserved specimens of other localities, as was done by BARAN et al. (2007), and published in earlier papers (BARAN 1969; BARAN & ATATÜR, 1986; BARAN et al. 2007; ÇEVİK et al. 2006). The morphometric measurements were made with a dial caliper of 0.02 mm sensitivity according to BARAN (1969) and TERENTJEV & CHERNOV (1965): Snout-Vent Length (SVL), Head Length (HL), Head Width (HW), Internarial Distance (ND), Interorbital Distance (ED), Humerus Length (HUL), distance from the tibio-tarsal ankle to the tip of the longest toe (RUD), Femur Length (FL), Tibia Length (TL), Foot Length (FOL), Metatarsal Tubercle Length (CIL), First (innermost) Toe Length (DPL).

Prior to the statistical analyses, morphometric measurement results were log<sub>10</sub>-transformed. Within each feature, the data were normally distributed (Kolmogorov-Smirnov D test, all  $P > 0.05$ ), thus allowing comparisons using parametric tests. To compare the morphometry of sexes and to determine statistical differences of morphological characters between localities, an independent samples t-test was used.  $P$  values of less than 0.05 were considered statistically significant. The morphological similarity among populations was visualized in applying a Cluster Analysis (single linkage method) using SPSS ver. 15.0 (SPSS 2006).

## RESULTS

Ground color of the dorsum of Karagöl-Çamlıyayla specimens was yellowish green to grayish green, with dark brown, occasionally dark greenish maculations. In the Seviçova-Ereğli and Uludağ-Bursa populations, the ground color of the dorsum varied from olive-brown to dark chocolate brown or different hues of gray, with dark roundish or oval maculations, usually with

indistinct borders. In the Karagöl-Çamlıyayla population, the dorsal maculations were encircled with lighter colored rims. The maculations across the hind limbs were arranged in transverse bands. None of the examined material had a vertebral stripe. The skin of the dorsum was smooth, without any granulation or warts (Fig. 1). In these features the Karagöl-Çamlıyayla specimens

Tab. 1: Minimum, mean, maximum and standard deviation of the mean (SD) (in mm) of twelve measurements taken in five Anatolian brown frog populations. SVL - Snout-Vent Length, HL - Head Length, HW - Head Width, ND - Internarial Distance, ED - Interorbital Distance, HUL - Humerus Length, RUD - distance from the tibio-tarsal ankle to the tip of the longest toe, FL - Femur Length, TL - Tibia Length, FOL - Foot Length, CIL - Metatarsal Tubercle Length, DPL - First (innermost) Toe Length.

Tab. 1: Minimum, Mittel, Maximum und Standardabweichung des Mittelwertes (in mm) von zwölf Meßgrößen bei fünf anatolischen Braunfroschpopulationen. SVL - Kopf-Rumpf-Länge, HL - Kopflänge, HW - Kopfbreite, ND - Nasenlochabstand, ED - Orbitalabstand, HUL - Humeruslänge, RUD - Entfernung vom tibio-tarsal Gelenk zur Spitze der längsten Zehe, FL - Femurlänge, TL - Tibialänge, FOL - Fußlänge, CIL - Länge des Metatarsaltuberkels, DPL - Länge der ersten (innersten) Zehe.

	Karagöl-Niğde n = 12			Eğriğöl-Çamliyayla/Mersin n = 11			Seviçova-Ereğli/Konya n = 16			Karagöl-Çamliyayla/Mersin n = 5			Uludağ-Bursa n = 12							
	Min.	Mean	SD	Min.	Mean	SD	Min.	Mean	SD	Min.	Mean	SD	Min.	Mean	SD					
SVL	44.50	49.89	55.11	3.161	40.87	47.98	56.45	5.846	44.26	52.38	57.48	3.881	42.74	47.59	51.83	3.869	53.76	60.10	67.60	4.969
HL	11.92	14.22	15.68	1.122	10.22	13.01	14.97	1.456	13.96	15.62	16.82	0.998	11.17	13.41	14.97	1.633	14.28	16.44	20.24	1.735
HW	16.23	18.31	20.17	1.447	13.87	17.19	19.53	1.800	15.55	18.88	20.45	1.489	15.11	15.56	16.13	0.432	17.36	19.95	23.19	1.993
ND	3.18	4.09	4.83	0.560	3.50	4.37	5.13	0.528	3.74	4.52	5.27	0.441	3.46	4.11	5.14	0.758	3.65	4.50	5.31	0.470
ED	7.99	9.09	10.48	0.731	8.09	9.91	10.76	0.801	8.45	10.69	12.25	0.903	8.86	9.26	9.73	0.368	10.31	12.01	14.43	1.037
HUL	5.83	8.29	10.39	1.192	6.75	8.64	10.59	1.573	7.00	10.17	12.34	1.571	7.87	8.76	9.92	0.889	9.75	11.48	13.84	1.567
RUD	16.52	20.96	23.46	1.832	15.61	19.70	24.08	3.145	18.52	22.05	25.30	2.265	17.86	19.71	21.03	1.358	22.90	25.32	29.17	2.357
FL	21.90	25.88	28.35	2.261	20.70	24.29	29.81	3.417	21.04	26.72	31.11	2.529	23.31	24.50	25.62	1.006	28.34	33.02	36.09	2.604
TL	23.56	27.65	30.29	2.306	21.25	25.37	30.08	2.934	21.85	27.62	31.88	2.787	23.83	25.67	26.90	1.315	30.52	35.08	38.82	3.047
FOL	22.74	27.69	30.07	2.219	20.32	24.16	28.22	2.922	22.88	27.62	34.28	3.097	22.79	25.24	27.14	1.810	26.34	33.21	37.75	4.085
CIL	2.08	2.46	2.79	0.246	1.82	2.57	3.34	0.466	2.09	2.87	3.94	0.446	2.15	2.52	2.88	0.405	2.08	3.28	5.33	0.887
DPL	5.84	7.86	8.87	0.861	6.40	7.63	8.94	1.107	6.24	7.85	8.81	0.777	6.64	7.07	7.37	0.313	7.59	9.43	11.98	1.169

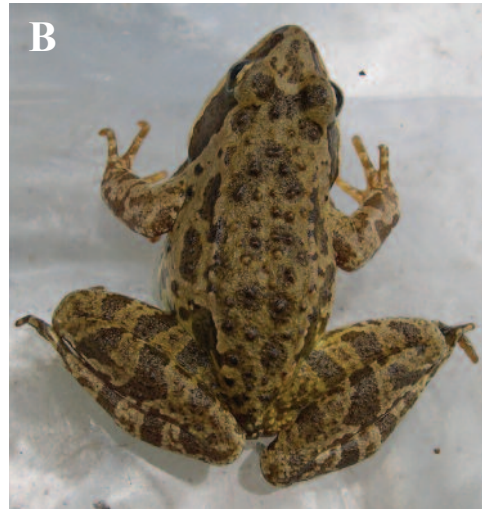
Table 2: Results of independent t-test comparisons. Morphometric data of the Karagöl-Çamliyayla specimens was compared with data of individuals from four known localities. Statistically significant differences are shown by asterisks (\*  $P < 0.05$ ; \*\*  $P < 0.01$ ). For explanation of measurement abbreviations see Table 1. Tab. 2: Ergebnisse von unabhängigen t-Tests, in denen morphometrische Daten der Exemplare von Karagöl-Çamliyayla mit Daten von Individuen der vier übrigen bekanntesten Vorkommen verglichen wurden. Auf statistisch signifikante Unterschiede wird durch Sternchen hingewiesen (\*  $P < 0.05$ ; \*\*  $P < 0.01$ ). Erklärung der Abkürzungen für die Meßgrößen siehe Tab. 1.

	Karagöl-Niğde		Eğrigöl-Çamliyayla		Seviçova-Ereğli		Uludağ-Bursa	
	t	P	t	P	t	P	t	P
SVL	2.06	0.058	0.69	0.500	3.07	0.006**	5.58	0.000**
HL	2.04	0.059	0.51	0.618	4.21	0.000**	3.93	0.001**
HW	4.30	0.001**	2.46	0.028*	5.17	0.000**	5.29	0.000**
ND	0.41	0.689	1.35	0.197	2.27	0.035*	1.98	0.066
ED	0.67	0.516	2.27	0.040*	3.90	0.001**	6.06	0.000**
HUL	-0.20	0.846	0.23	0.823	2.32	0.032*	4.40	0.001**
RUD	1.90	0.077	0.33	0.747	2.73	0.013*	5.66	0.000**
FL	1.98	0.067	0.55	0.590	2.58	0.018*	6.78	0.000**
TL	2.35	0.033*	0.40	0.693	2.07	0.053	7.21	0.000**
FOL	2.70	0.016*	-0.08	0.936	2.25	0.037*	4.75	0.000**
CIL	0.63	0.539	0.78	0.449	2.26	0.036*	2.37	0.032*
DPL	2.27	0.039*	1.38	0.190	2.59	0.018*	5.22	0.000**

resembled the Karagöl-Niğde and Eğrigöl-Çamliyayla populations. However, presence of the vertebral stripe to various degrees, absence of lighter colored rims around the dorsal maculae, and granulated skin separated the Uludağ-Bursa and Seviçova-Ereğli populations from the Karagöl-Çamliyayla specimens.

The morphometric measurements of females and males did not differ significantly ( $P > 0.05$ ) and, thus, were pooled. Descriptive statistics of the measurements are given in Table 1. Independent samples t-test of the mean values in Table 1 showed differences in morphometric measurements between the localities (Table 2). According to these tests, four morphometric parameters (HW, TL, FOL and DPL) discriminated statistically significant between the populations of Karagöl-Niğde and Eğrigöl-Çamliyayla, whereas two (HW and ED) distinguished statistically significant between the Eğrigöl-Çamliyayla and Karagöl-Çamliyayla populations (Table 2). After all, the Karagöl-Çamliyayla population was clearly different from the Seviçova-Ereğli and Uludağ-Bursa populations in all parameters except two (TL and ND) (Table 2). The size (SVL, mm) of the Karagöl-Çamliyayla specimens (42.74 - 51.83, mean = 47.59) was very similar to the size of the Eğrigöl-Çamliyayla specimens (40.87-56.45, mean = 47.98). On the average, the Karagöl-Niğde individuals were 5%, the Seviçova-Ereğli individuals 10%, and the Uludağ-Bursa individuals 26% larger than the Karagöl-Çamliyayla individuals.

Based on the population mean values of the morphological measurements, the Single Linkage Method clustered the five populations in the following way (Fig. 2): The Eğrigöl-Çamliyayla and Karagöl-Çamliyayla populations were tightly linked to the Karagöl-Niğde population, whereas the Seviçova-Ereğli and Uludağ-Bursa populations were linked at some distance to the former cluster and between each other. According to the diagram (Fig. 2), Karagöl-Çamliyayla/Mersin specimens showed considerable similarity to the Karagöl-Niğde and Eğrigöl-Çamliyayla/Mersin populations, whereas they appeared clearly separated from the Uludağ-Bursa and Seviçova-Ereğli/Konya populations.



## DISCUSSION

Since the late 19th century, reports of the herpetofauna of Turkey refer to three mountain dwelling brown frog nominal taxa, *Rana holtzi*, *Rana camerani* BOULENGER, 1886, and *Rana macrocnemis*. The taxonomic status of Anatolian brown frogs (also called mountain frogs) has always been questioned since the early 1900's (FRANZEN et al. 2008). BOULENGER (1898) believed that *R. holtzi* was a synonym of *R. camerani* and WERNER (1902) accepted this idea. However, after investigation of comprehensive material, WERNER (1914) reverted to his former belief that *R. holtzi* was a distinct species. LANTZ & CYRÉN (1913) and BODENHEIMER (1944) asserted that *R. camerani* was identical with *R. macrocnemis*. According to DELWIG (1928), these forms were local subspecies of one single species. Based on the examination of the same materials, BARAN (1969) and ÖZETI (1970) suggested that three morphologically/osteologically distinct species live in Turkey. On the contrary, ISHCHENKO (1978, 1987), claimed that in the Caucasus region, only one brown frog taxon, *R. macrocnemis*,

Fig. 1: Individuals of *Rana holtzi* WERNER, 1898, from three locations. Figures at different scales.  
A - Karagöl-Niğde (type locality),  
B - Eğrigöl-Çamliyayla, Mersin,  
C - Karagöl-Çamliyayla, Mersin (the new record locality).

Abb. 1: Individuen von *Rana holtzi* WERNER, 1898 von drei Fundorten.  
Abbildungen in unterschiedlichen Maßstäben.  
A - Karagöl-Niğde (Typuslokalität),  
B - Eğrigöl-Çamliyayla, Mersin,  
C - Karagöl-Çamliyayla, Mersin (der neue Fundort).

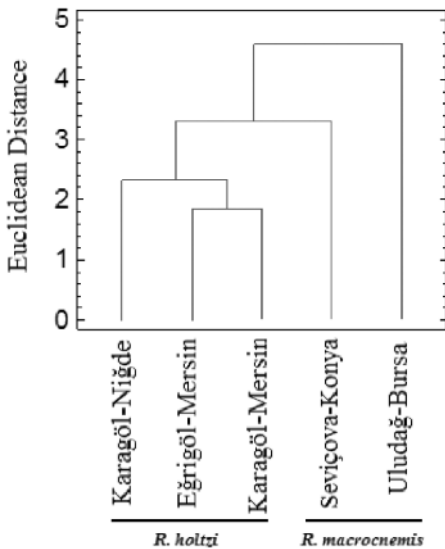


Fig. 2: Phenogram (based on the mean values in Table 1) showing the morphological similarity of brown frog populations from selected Anatolian localities.

Abb. 2: Phänogramm (auf Basis der Mittelwerte in Tab. 1) zur Veranschaulichung der morphologischen Ähnlichkeit von Braunfroschpopulationen ausgewählter anatolischer Fundorte.

was present as a greatly variable, monotypical species, *R. camerani* representing neither a distinct species nor a subspecies but a mere synonym of the former. More recently, TARKHNISHVILI et al. (1999) and TARKHNISHVILI & GOKHELASHVILI (1999) mentioned that there were two geographical subspecies of *R. macrocnemis* (viz. *macrocnemis* and *camerani*) present in the Caucasus region. ARIKAN et al. (2001) failed to find morphological and serological differences significant at species level between the brown frogs of the Mid-Taurus Range. TARKHNISHVILI et al. (2001) reported that mtDNA, allozymes and morphological data of *R. macrocnemis* and *R. camerani* showed “a highly congruent pattern in a limited area in the south-west Caucasus”, and in the remaining distribution areas, hybridization between these forms resulted in a clinal pattern of variation. VEITH et al. (2003a) stressed that comparative gross morphology is not a suited tool for delineation of evolu-

tionary lineages of Anatolian mountain frogs and that *R. macrocnemis*, *R. camerani* and *R. holtzi* are not monophyletic according to DNA sequencing analyses. Contrary to the above, it was reported that the species *R. holtzi* and *R. camerani* form a monophylum with *R. macrocnemis* (VEITH et al. 2003b). However, the relevant haplotype B11 (from 16s rRNA) for six *R. holtzi* from the type locality was also frequently found in other populations of the Bolkar Mountains and other Anatolian “*macrocnemis*” populations. From their S1 satellite DNA and morphology studies, PICARIELLO et al. (1999), suggested that the three previously supposed species, *R. macrocnemis*, *R. camerani* and *R. holtzi* should be included in a single species and named *R. macrocnemis* BOULENGER, 1885, for reasons of nomenclatural priority. ÇEVİK et al. (2006) who studied Anatolian mountain frogs from Uludağ, Erciyes Mountain, and Karagöl using morphological features and electrophoresis concluded that *R. holtzi* is a distinct mountain frog species.

In the present phase of inconsistent molecular results, the authors favor morphological, ecological and behavioral traits to substantiate their view on the status of Anatolian mountain frogs. In our opinion *R. holtzi* is a rare and local endemic of Turkey, correctly classified as Critically Endangered (CR) in the IUCN Red List (OLGUN et al. 2008) in consequence of its restricted geographic distribution (BARAN 1969; BARAN & ATATÜR 1986; BARAN et al. 2007; ÇEVİK et al. 2006) and declining population size (BARAN et al. 2001; KAYA et al. 2005, 2010). Although, this species was described more than a hundred years ago, only two record localities were known for decades. Only in 2007, a third site (Eğrigöl-Çamliyayla) was discovered by BARAN et al. (2007), based on the morphology of the specimens found there. In the same study, the frog population of Seviçova-Ereğli, which is located approximately 500 m below Eğrigöl-Çamliyayla, is described as *R. macrocnemis*. Karagöl-Çamliyayla, where the present new population was detected, lies approximately 30 km southwest of Karagöl-Niğde and about 10 km southwest of Eğrigöl-Çamliyayla. Geographic structure and landscape features of the locations at Karagöl-Çam-



Fig. 3: Karagöl-Çamliyayla (Mersin), the new record locality of *Rana holtzi* WERNER, 1898, in the Bolkar Mountains (Turkey).

Abb. 3: Karagöl-Çamliyayla (Mersin), der neue Fundort von *Rana holtzi* WERNER, 1898 im Bolkar-Gebirge (Türkei).

liyayla are very similar to Eğrigöl-Çamliyayla and Karagöl-Niğde localities since all three lakes are formed by snow water and fed by small underground waters in the summer. Like the others (comp. SCHMIDTLER et al. 1990), the Lake of Karagöl-Çamliyayla is surrounded by alpine meadows, and some emergent vegetation (*Polygonum* sp., *Potamogeton* sp. and *Juncus* sp.) is present in the water body (Fig. 3).

The brown frog specimens from Karagöl-Çamliyayla had a smooth skin, dorsal maculations of variable shape, encircled with lighter rims, and lacked a vertebral stripe. Most morphological measurements deviated significantly from measurements of *R. macrocnemis* populations

studied (Seviçova-Ereğli and Uludağ-Bursa). In addition, SVL of the Karagöl-Çamliyayla specimens was clearly smaller than of the Uludağ-Bursa and Seviçova-Ereğli brown frog specimens. Regarding all these morphological findings, the Karagöl-Çamliyayla specimens are completely in accordance with *R. holtzi* (ARIKAN et al. 2001; BARAN 1969; BARAN & ATATÜR 1986; BARAN et al. 2007; ÇEVİK et al. 2006). Cluster analysis mirrored the above affinities, in that the Karagöl-Niğde, Eğrigöl-Çamliyayla and Karagöl-Çamliyayla populations were morphologically similar among each other and placed at some distance to the Seviçova-Ereğli and even more the Uludağ-Bursa populations.

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