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Research Article

Contribution to the taxonomic knowledge of *Acanthodactylus* (Squamata, Lacertidae): Description of a new lacertid lizard species from Eastern Anatolia, Turkey

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Abstract

Acanthodactylus Wiegmann, 1834 is one of the most diverse and widespread lizard genus in the Palearctic realm. Here, we describe a new species, - *Acanthodactylus ilgazi* **sp. nov. -** from the Anatolian Peninsula. This new species ranges approximately 250 km north from the closest population of this genus in Turkey. Compared to other fringe-fingered lizards, the new species is phylogenetically close to *A. robustus*, *A. tristrami* and *A. orientalis* but it has some distinct morphological characteristics: reddish coloration under the tail, a sharp white or grayish stripe in the middle of the dorsum, and four plates in a row on the 4th finger. Moreover, phylogenetic molecular data, based on *cyt b* gene fragment, verifies that the new species is phylogenetically a member of the *tristrami* species group with 13.03%, 17.35% and 20.56 genetic distance respectively from *A. orientalis*, *A. tristrami* and *A. robustus*. Lastly, the known range of this species, located in Yazıhan, Malatya in Eastern Anatolia, is restricted by a dam, thus habitat loss endangers its continuity. Therefore, the conservation status of this species should be assessed immediately.

Keywords: Anatolian Peninsula, fringe-fingered lizard, phylogeny, new species, *cyt b*

Introduction

Acanthodactylus, fringe-fingered lizards, is a taxonomically very diverse genus (Salvador, 1982; Arnold, 1983; Yalçınkaya & Göçmen, 2012; Tamar et al., 2016) including about 44 species around the world (Uetz et al., 2020). This genus is generally distributed in North Africa, Southwest Asia, and Southwest Europe (Iberian Peninsula) (Tamar et al., 2016). The genus includes diurnal and ground dwelling lizards, that have adapted to live in many ecological environments including arid ecosystems, open woodlands, scrub, savannah and sandy areas (Salvador, 1982; Arnold, 1983; Sindaco & Jeremčenko, 2008; Yalçınkaya & Göçmen, 2012; Tamar et al., 2016). The genus *Acanthodactylus* is considered a group that is taxonomically very difficult to solve by herpetologists because some species, i.e., *A. boskianus* (Daudin 1802), have great intraspecific morphological variations (Salvador, 1982; Arnold, 1983). Many revisions have been carried out on the genus using morphology, osteology, and hemipenial differences (Boulenger, 1918; Salvador, 1982; Arnold, 1983; Harris & Arnold, 2000) and phylogeny (Harris & Arnold, 2000; Harris et al., 2004; Fonseca et al., 2008, 2009; Carretero et al., 2011; Heidari et al., 2014; Tamar et al., 2014, 2016; Miralles et al., 2020). According to a recent phylogenetic study by Tamar et al. (2016), *Acanthodactylus* should be divided into three well-supported clades as before stated by Harris & Arnold (2000), and into ten different phylogenetic species groups within them.

The Anatolian distribution of *Acanthodactylus* is limited to the following three species so far: *i*) *A. boskianus* (Daudin, 1802), *ii*) *A. harranensis* Baran, Kumlutaş, Lanza, Sindaco, Ilgaz, Avcı & Crucitti, 2005, and *iii*) *A. schreiberi* Boulenger, 1878 (Baran et al., 2005; Yalçınkaya & Göçmen, 2012; Kurnaz, 2020; Baran et al., 2021). *Acanthodactylus boskianus* has only been recorded at the locality from Birecik (Şanlıurfa, Southeastern Anatolia) (Böhme, 1973; Baran, 1980), *A. harranensis* is distributed in a very restricted area from Harran (Şanlıurfa, Southeastern Anatolia) in a vicinity of ruins of the ancient university located on the Harran Plateau (Baran et al., 2005), therefore, it is endemic to the Anatolian Peninsula. The remaining fringe-fingered lizard, *A. schreiberi,* is reported from Botaş-Adana and on the coast of Burnaz (Franzen, 1998; Sindaco et al., 2000; Yalçınkaya & Göçmen, 2012; Akman, 2019). The common feature of these three lizards is that all species are distributed in the southern and southeastern part of the Anatolian Peninsula. Additionally, the altitudinal limit of these lizards can reach up to 600 meters (Baran et al., 2021).

Although the first record of *Acanthodactylus* from Turkey was given by Böhme (1973) as *A. boskianus*, the number of species increased to three within two decades (Franzen, 1998; Baran et al., 2005; Yalçınkaya & Göçmen, 2012). The aim of the present study is to describe a new *Acanthodactylus* species from Yazıhan, Malatya in Eastern Anatolia, approximately 250 km north from the closest known fringe-fingered lizard locality in Turkey.

Material and methods

Study area

Three lizard specimens (2 ♀♀, 1 juvenile) were collected from the north of Yazıhan, vicinity of Boztepe and Koşar villages, Malatya Province in Eastern Anatolia (Lat: 38° 41’ 32” N – Long: 38° 10’ 13” E and about 950 m a.s.l.). Yazıhan is among the driest areas in Eastern Anatolia, with annual rainfall averaging about 264 mm and air temperature varying from –2 °C during winter to 35 °C during summer. The locality is shown in Figure 1. All specimens were anesthetized with ether, fixed with a 96% ethanol (Candan et al., 2019) and deposited in the Zoology Laboratory (collection number: ZDEU 2/2020 1-3) of the Department of Biology at the Faculty of Science, Dokuz Eylül University.

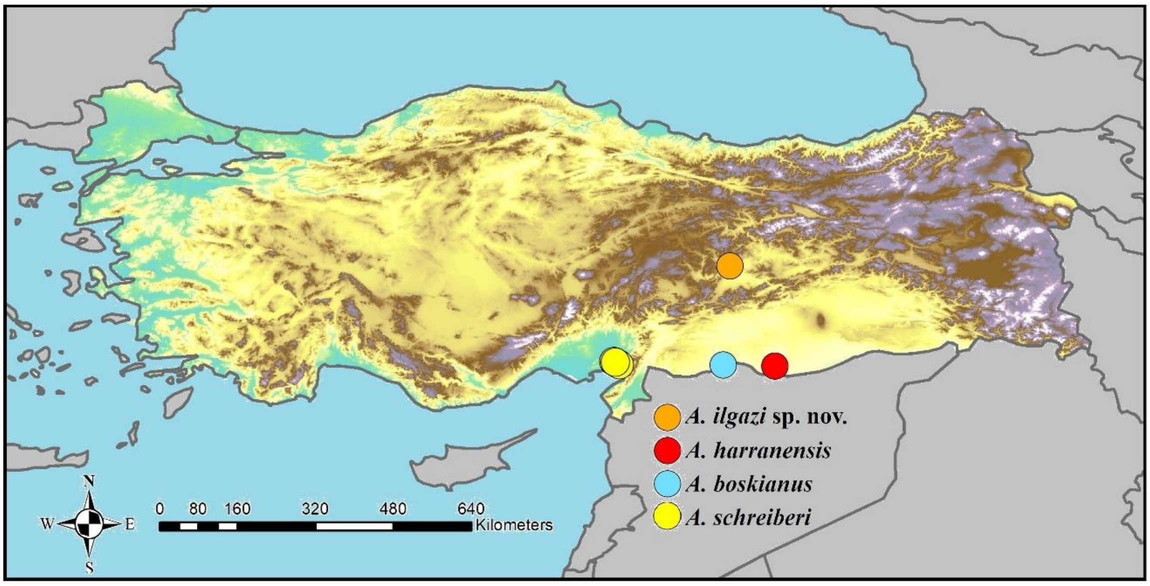

Figure 1. The map shows distribution of the genus *Acanthodactylus* in Turkey.

Morphological examinations

The metric and meristic characters were examined for each of the three specimens. For morphometric measurements, we used a digital caliper and pixel based software (Alamet 0.06) of 0.1 and 0.01 mm sensitivity, respectively (The measurements were performed by Mehmet Kürşat Şahin). Mensural and meristic data were recorded and compared to Salvador (1982), Arnold (1983), Baran et al., (2005) and Heidari et al., (2013).

The studied mensural characters were as follows: Snout to vent length (SVL): from tip of snout to caudal edge of anal scales; Tail length (TL): from caudal edge of anal scales to tip of tail, on complete original tails only; Head width (HW): at the widest point of head; Head height (HH): from upper surface of head to lower surface of chin; Head length (HL): from tip of snout to posterior edge of tympanum; Pileus width (PW): at widest point between parietal plates; Pileus length (PL), tip of snout to posterior margins of parietals; Fore limb length (FLL); Hind limb length (HLL); Anal plate length (AL); Anal plate width (AW).

Meristic characters examined were as follows: Supraciliary granules (right–left, SCGa–SCGb); Number of Loreal plates to the back of postnasal plates and to the front of preocular plates (right–left, LOa–LOb); Supraciliar plates (right–left, SCPa–SCPb); Supralabial plates (right–left, SRLa–SRLb, number of labials both anterior and posterior to center of eye); Sublabial plates (right–left, SLPa–SLPb); Inframaxillary plates (right–left, IMa–IMb); Transversal series of gular scales between inframaxillary symphysis and collar (MG); Collar (C); Supratemporals (right–left, STa–STb); Ventral plates (transversal and longitudinal, TVP and LVP); Femoral pores (right–left, FPa–FPb); Subdigital lamellae on the fourth toe (right–left, SDLa– SDLb); Transversal series of dorsal scales at the midbody (DS); Number of preanal scales in front of anals (PA1) and all plates surrounding anals (PA2).

Molecular analyses

The clipped tip of tails obtained from collected specimens was kept in 96% ethanol at -20 ºC. Later, for DNA isolation from tissues, the tissues were cut into small pieces and the DNA was isolated from tissues using the CTAB procedure (Doyle & Doyle, 1990).

Fragment of the mitochondrial cytochrome b gene (*cyt b*; 405 bp) was amplified for the three specimens using primers *GludG* (F: TGACTTGAARAACCAYCGTTG) (Palumbi 1996) and *Cytb2* (R: CCCTCAGAATGATATTTGTCCTCA) (Kocher et al., 1989). *cyt b* gene amplification involved an initial incubation at 94 ºC for five minutes, followed by 35 cycles at 94 ºC for 30 seconds, the appropriate annealing temperature at 49 ºC for 45 seconds, elongation temperature at 72 ºC for 90 seconds and final extension temperature at 72 ºC for five minutes. Amplified DNA segments were purified and sequenced by BM Labosis in Ankara, Turkey.

Phylogenetic analyses were based on the three *cyt b* gene sequences obtained from the collected specimens from Turkey, and additional sequences of *Acanthodactylus* species retrieved from GenBank. Accession numbers of all sequences used for the phylogenetic analysis are from the studies of Tamar et al. (2016) and Psonis et al. (2016). All *cyt b* sequences used in the molecular analysis were aligned using Geneious Prime 2019. The best-fit substitution model was determined with JModelTest v.2.1.8 (Darriba et al., 2012) and the best model was chosen according to the lowest AIC (Akaike's information criteria) degree (Akaike, 1974). To reconstruct the phylogenetic tree, we carried out a Bayesian Inference (BI) analysis by using MrBayes v.3.2.6 (Ronquist et al., 2011). In the BI analysis, the following settings were used: number of Markov Chain Monte Carlo (MCMC) generations = ten million; sampling frequency = 100; burn-in = 25%. The BI tree topology was determined based on Bayesian posterior probability (BPP). We considered nodes with a BPP of 95% or greater as significant (Leachè & Reeder, 2002). The Bayesian tree was visualized with FigTree v.1.4.4 (Rambaut, 2018). Uncorrected pairwise sequence divergences for the *cyt b* gene were calculated using MEGA 7.0 v (Kumar et al., 2016).

Results

Morphology

Morphological characteristics of the three newly collected specimens of the new species described herein are listed below. The new species is relatively similar to *A. tristrami* (Günther 1864) and *A. orientalis* Angel, 1936 in terms of some pholidolial characteristics (the number of longitudinal ventral plates, carination of dorsum, number of nasal plate, unpectinated eyelid, unkeeled temporals and number of prefrontals) and color pattern (Table 1); however, it also has several different characteristics from them. The reddish coloration under the tail, the sharp white or grayish stripe in the middle of the dorsum, and four plates in a row on the 4^{th} finger are some of the major characteristics that differ from adult specimens of *A. tristrami* and *A. orientalis*. On the other hand, even though the new collected specimens and *A. robustus* are phylogenetically nested within the same group (see below), they have very distinct morphological characters. The most important difference is that the subocular plates of *A. robustus* do not contact the infralabial plates. In addition, *A. robustus* has 12 ventral plates, high dorsal scale numbers (51-60) and three unfragmented supraocular plaques.

Table 1. Some morphological characteristics used in the present study for discrimination of *Acanthodactylus* species (Abbreviation: SOP: number of supraocular plates; CD: Carination of dorasalia; NP: number of nasal plates; T: temporal keeling; ELP: eyelid pectination; PF: number of prefrontals; TP: toes pectination; TS: number of toes scalation; LVP: Longitudinal ventral plates; K: Keeled; UK: Unkeeled; SK: Less keeled; P: Pectinated; UP: Unpectinated; SP: Less pectinated). The + sign was used for species with similar characteristics to the newly described taxon.

Characters	**SOP**	**LVP**	**CD**	**NP**	**T**	**ELP**	**PF**	**TP**	**TS**
Species									
A. boueti	1	12	K	2	**UK**	**UP**	**4**	UP	3
A. guineensis	**2**	10	SK	3	**UK**	**UP**	2	UP	3
A. boskianus	4	10	K	2	K	P	2	**P**	3
A. savignyi	**2**	10	K	2	**UK**	P	**4**	**P**	3
A. masirae	4	10	K	2	**UK**	P	2	**P**	**4**
A. micropholis	**2**	10	**UK**	2	**UK**	P	2	UP	3
A. erythrurus	**2**	10	**UK**	2	**UK**	**UP**	2	UP	3
A. tristrami	**2**	10	**UK**	2	**UK**	**UP**	2	UP	3
A. orientalis	3	10	**UK**	2	**UK**	**UP**	2	**P**	3
A. ahmaddisii	3	11	**UK**	2	**UK**	**UP**	2	UP	3
A. beershebensis	3	10-14	**UK**	2	**UK**	**UP**	2	UP	3
A. lacrymae	3	8-12	**UK**	2	**UK**	**UP**	2	SP	3
A. montanus	3	8-12	SK	2	SK	**UP**	2	SP	3
A. robustus	3	12	**UK**	2	**UK**	**UP**	2	UP	3
***A. ilgazi* sp. nov.**	**2**	**10**	**UK**	2	**UK**	**UP**	2	**P**	**4**

A. boueti									
A. guineensis	**+**	**+**							
A. boskianus									
A. savignyi	**+**	**+**							
A. masirae									
A. micropholis	**+**	**+**	**+**	+	**+**				
A. erythrurus	**+**	**+**	**+**	**+**	**+**	**+**	**+**		
A. tristrami	**+**	**+**	**+**	**+**	**+**	**+**	**+**		
A. orientalis									
A. ahmaddisii									
A. beershebensis									
A. lacrymae									
A. montanus									
A. robustus									
***A. ilgazi* sp. nov.**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**

Phylogenetic relationships and genetic diversity

A total of 405 bp fragment of *cyt b* gene was obtained for the three newly collected specimens from Turkey. The *cyt b* had 205 variable positions. According to model test results, the best-fit substitution model was GTR+G+I. Phylogenetic tree topology shows that *Acanthodactylus* is divided into three clades, though with no support, named – Eastern, Western, and *scuttelatus* (Figure 2). *Acanthodactylus guineensis* is sister to these three clades, presented by the number 12. The new species is included in the Western clade and within it to the *tristrami* species group with its three recognized members (BPP = 0.99). Within the species group, *A. robustus* was the first to diverge, followed by *A. tristrami*, though with weak support. The new species is phylogenetically close and sister to *A. orientalis* (BPP = 1). The *cyt b* genetic distance from *A. robustus* is about 20.56%, from *A. tristrami* is about 17.35%, and from *A. orientalis* is about 13.03% (Table 2).

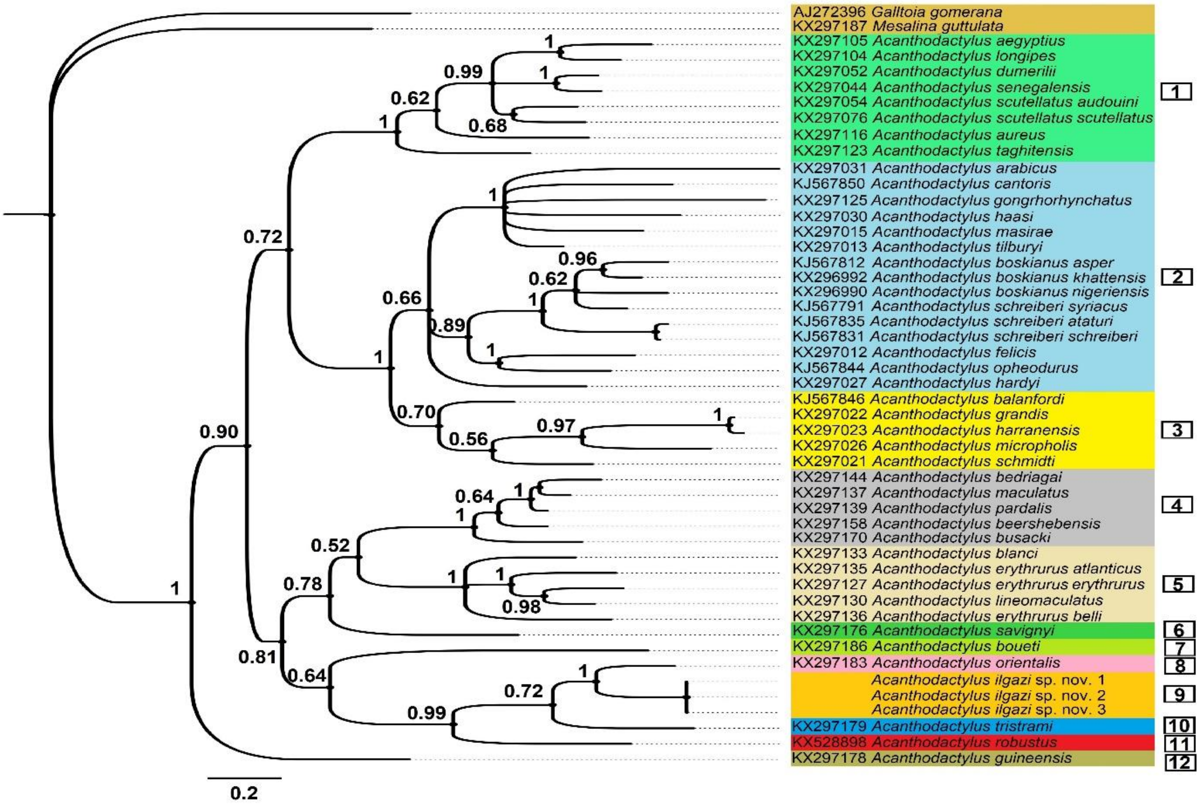

Figure 2. Bayesian Inference phylogenetic tree based on *cyt b* gene data set. Bayesian posterior probability values are given at each node. The numbers in the right side of the figure represent the phylogenetic groups used in genetic distance calculations.

Table 2. Uncorrected genetic distance among *Acanthodactylus* species based on mitochondrial *cyt b* fragment. The numbers in the table from 1 to 12 show phylogenetic groups used in Figure 1.

Groups	1	2	3	4	5	6	7	8	9	10	11	12
1	-											
2	25.66	-										
3	23.19	20.61	-									
4	24.38	28.21	27.16	-								
5	28.61	27.50	26.84	23.62	-							
6	25.43	25.67	22.76	22.41	21.87	-						
7	27.71	28.09	26.02	25.74	27.28	23.47	-					
8	29.65	28.62	27.22	26.42	28.33	24.99	28.92	-				
9	28.17	26.29	24.75	23.33	25.63	24.05	23.31	13.03	-			
10	25.26	27.85	25.37	24.20	25.74	24.28	27.43	15.90	17.35	-		
11	24.34	26.93	25.22	22.80	27.36	23.42	23.95	18.10	20.56	19.31	-	
12	28.17	24.43	26.09	21.09	22.99	24.49	24.94	26.77	25.25	25.99	22.49	-

Taxonomic account

Our genetic findings show the three collected specimens from Eastern Turkey represent a unique lineage within the genus *Acanthodactylus*. This result is demonstrated in both morphological examinations (Table 1) and genetic analyses (Figure 2). Therefore, we describe these newly collected specimens as a new species.

Figure 3. General view of the holotype of *Acanthodactylus ilgazi* **sp. nov.** (ZDEU 2/2020-1) adult female. **a.** dorsal view, and **b.** ventral view.

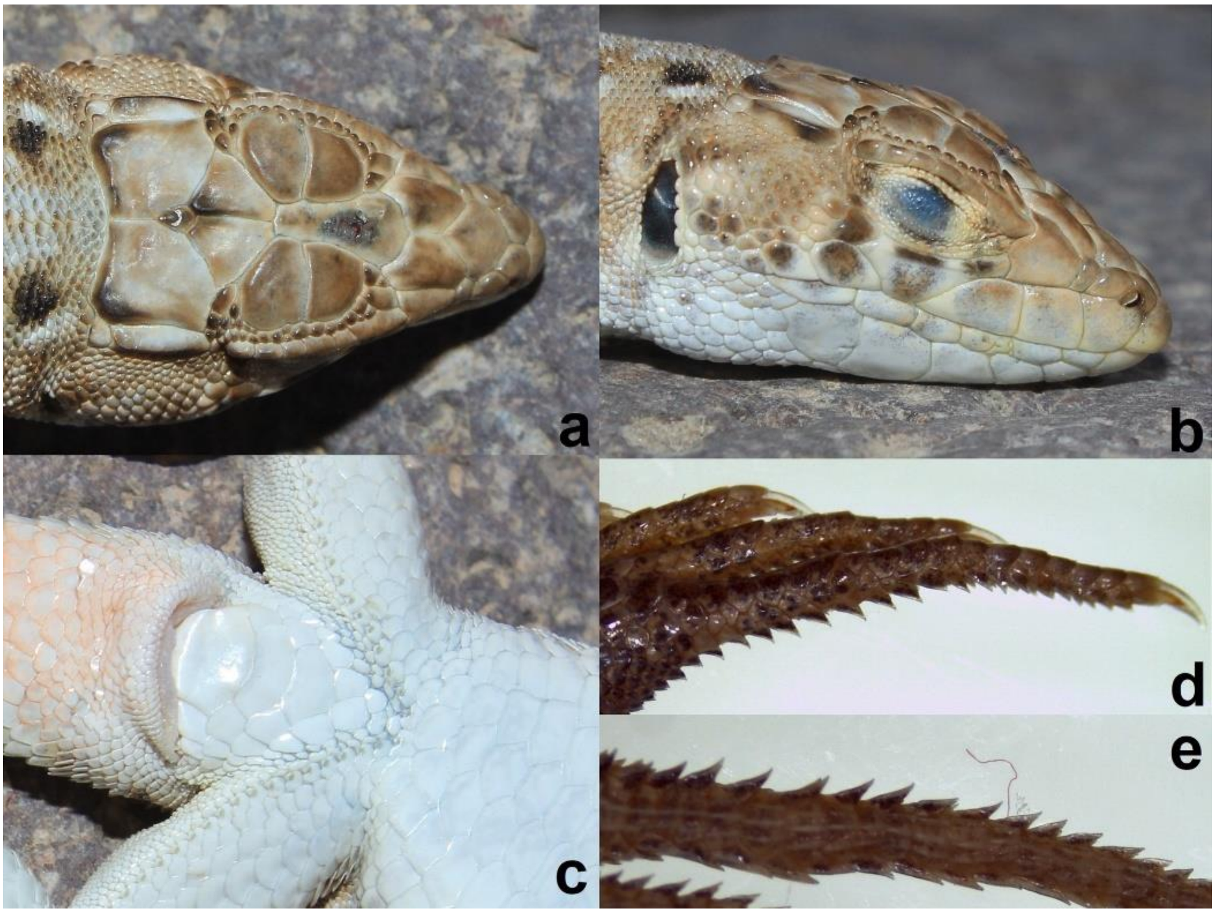

Figure 4. Some pholidolial characters of holotype of *Acanthodactylus ilgazi* **sp. nov.** (ZDEU 2/2020-1), adult female. **a.** dorsal view of the head, **b.** lateral view of the head (right view), **c.** anal plates and femoral pores, **d.** toe pectination, and **e.** a three carinated toe.

Acanthodactylus ilgazi sp. nov.

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(Figures 3 – 4; Table 3)

Holotype

An adult female specimen (ZDEU 2/2020-1), collected from a rural area in Yazıhan, vicinity of Boztepe and Koşar villages, Malatya Province (Lat: 38° 41’ 32” N – Long: 38° 10’ 13” E and about 950 m a.s.l.) in Eastern Anatolia, Turkey, during a field study on 16 August 2020, by Muammer Kurnaz and Mehmet Kürşat Şahin.

Paratypes

A female (ZDEU 2/2020-2) (Figure 5) and juvenile specimen (ZDEU 2/2020-3) (Figure 6) with collection details as the holotype.

Diagnosis

Acanthodactylus ilgazi **sp. nov.** is medium sized (SVL: 73.60 – 77.40 mm; Total length 144.40 – 157.30 mm) and robust body (Figure 3a, b). The head is relatively more convex in all specimens; parietals and supraoculars are moderately keeled; suboculars on both sides reach the mouth, four supralabials (rarely three) in anterior of suboculars; two supraocular plates on the head, 1st and 4th supraoculars fragmented. One or two rows of granules are present between supraoculars and supraciliaries; four unpectinated scales on the ear opening; medium sized circle of unkeeled temporals; suboculars keeled in upper side; 23–28 gularia between third inframaxillary and collars. The last 3–4 rows of gularia are as collars; generally, 10 longitudinal rows of ventral plates, and 28–31 ventral series in a longitudinal row along the belly between collar and preanal; 48–50 (mean 49) dorsal midbody scales, imbricated and not keeled. They are larger in the middle of the dorsum and are smaller towards the lateral sides; 19 – 23 femoral pores on the right side. The tail length is almost equal to SVL in all specimens. Four rows of scale series on the fingers (one smooth scale in upper side, two pectinated scales in lateral side and one scale with three carina underside); toes with three carinated scales on the subdigital lamellae; 21–22 pectinated lamellae beneath 4^{th} toe.

Differential diagnosis

Acanthodactylus ilgazi **sp. nov.** is a typical member of the *tristrami* species-group, differing from the other members of the species-group by the following characters:

Acanthodactylus ilgazi **sp. nov.** differs from *A. orientalis* in that there are two unfragmented supraocular plates (vs. three in *A. orientalis*); four rows of scale series on the fingers (vs. three in *A. orientalis*); reddish coloration of the underside of the tail, and the white or grayish stripe on the dorsum.

Acanthodactylus ilgazi **sp. nov.** differs from *A. robustus* in that the subocular plates contacts the lower lip between 4th and 5th supralabials; lower number of ventral plates (10 vs. 12, respectively); lower number of dorsal scale (max. 50 vs 51-60, respectively) and lower number of unfragmented supraocular plaques (2 vs. 3, respectively).

Acanthodactylus ilgazi **sp. nov.** differs from *A. tristrami* in that there is lower number of dorsal scales (max. 50 vs. 52-64); four rows of scale series on the fingers (vs. three in *A. tristrami*); reddish coloration of the underside of the tail, and the white or grayish stripe on the dorsum.

Description of the holotype

A robust but not depressed, body shape. Head length (16.71 mm) and head width (13.14 mm); the length-width ratio of the head is 1.27. The ratio of tail length (79.90 mm) to SVL (77.40 mm) is relatively equal, that is 1.03. The ratio of the pileus length (13.78 mm) to width (6.90 mm) is twice higher; scales above and on sides of tail relatively smooth (except for those of the vertebral row which are mostly weakly keeled), and tail includes 85–87 feeble vertebra. Limbs are relatively slender: forelimbs 22.40 mm, about 29% of snout-vent length; hind limbs 38.70 mm, about 1.7 times of forelimbs and 50% of snout-vent length. Forelimbs have larger imbricate shields in dorsal surface and small granules ventrally; conversely, dorsal surface of hind limbs (on thigh and tibia) have small scales, similar to dorsalis, and enlarged, smooth and imbricate shields in ventral surface of hind-limbs. The head shields are relatively convex; supraoculars and parietals moderately keeled. Rostral and frontonasal are not contacted; supranasals block the connection between them with a deep suture. Rostral is rather round, not pointed; snout not very pointed. Nasal region is not swollen. Nostril is bordered by postnasal, supranasal and first supralabial. The frontonasal plate is large with width almost longer than 1.4 times the length. Two intact supraoculars, the second and third; the first and forth supraocular plates fragmented, the first separating prefrontal-supraocular contact; Two prefrontal plates with medial contact; Frontal is wedge shaped, widest anteriorly, bordered by second and third supraocular laterally, by frontonasals anteriorly and by frontoparietals posteriorly; parietals are nearly as wide as their length. Interparietal is small, wedge shaped, widest anteriorly, with a minute parietal foramen; no occipital; Although there is a small tympanicum, it is sometimes difficult to distinguish from temporal plates; ear opening vertical and relatively elliptical, its diameter longer than orbit relatively 2.5 times; relatively medium sized temporal scales (larger ventrally and smaller dorsally). Two supratemporals, the anterior long and the posterior smaller and granular-shaped; no postorbital; 6–7 supraciliaries on each side, the anterior-most is the largest, separated from supraoculars by a complete rows of 15–16 granules (granules rarely two rows); 6–7 supralabials on right and left side, respectively, 3–4 anterior to subocular, respectively; subocular wider dorsally, twice as long as its width; 6 infralabials; five pairs of submaxillary shields, the first three pairs in contact; the last two pairs broadly separated; submaxillary shields bordered by 19 granules; 25 gular scales in a straight median line between the union of the submaxillaries and the central scale of the collar; collar consist of 8 plates with large scales, the last 3 rows of gularia are as collars; 48 dorsal scales at midbody, dorsal scales smooth and unkeeled), granular from nape to caudals, lateral scales relatively smaller than dorsum; ventral and dorsal caudals smooth, 15 large dorsal scales across dorsum between hindlimbs; enlarged ventrals in 10 strait longitudinal series (at the level of the widest transversal row) and 31 transverse rows; anal plate present, the ratio of width (4.41 mm) to length (2.68 mm) is 1.7; four enlarged circumanal plates in a longitudinal row between anterior cloacal margin and the gap between the two series of femoral pores, one preanal developed with one strongly enlarged plates; 19–21 femoral pores, in contact medially; four rows of scale series on the digits, one smooth scale dorsally, two pectinated scales laterally, and one three carinated scale ventrally; toes with three carinated on the subdigital lamellae; 21–22 pectinated lamellae beneath 4th toe.

Color and Pattern

The base coloration of the dorsum is light brown. There is a clear whitish or grayish stripe in the middle of the dorsum extending from the parietals to the coccyx. Wide dark brown stripes extending laterally from the midbody on both sides of the dorsum. Small white ocelli are scattered on the ends or inner part of the wide brown stripes. The upper head coloration is light brown; the outer margins of the parietals is dark brown. Temporal region is light brown with less maculation. The eye area is light brown to white in background color, with three vertical brown stripes. White ocelli appear faintly on the limbs. Brown and white spots also run along the dorsal side of the tail. The ventral coloration is generally white, sometimes dark grey coloration on the marginals and on the underside of the head. The underside of the tail is orange or reddish coloration. The coloration of juveniles is similar to adults. Brownish pattern is less prominent, while there are much white ocelli. Middle of dorsum is brownish. No striate in both adult or juvenile specimens.

Variation

The paratypes do not differ substantially from the holotype in the mensural (adult paratype) or meristic characters (both paratypes), varying slightly in size related measurements (Table 3).

Geographic Distribution and Habitat

The species is currently known only from the type locality of Yazıhan, Malatya province, Turkey. This locality is approximately 250 km north from the known localities of *Acanthodactylus* species ranging in Turkey. *Acanthodactylus ilgazi* **sp. nov.** lives in a narrow area at the foots of the small hills of the Yazıhan valley. The habitat consists of a sandy open ground area with little vegetation and scattered medium sized stones (Figure 7). Generally, three plant species are dominating the area, *Tamarix* sp., *Alhagi* sp., and *Xanthium strumarium*. The new species was mostly observed at the bottom of the *Tamarix* plants. The specimens were observed between 10:00–15:00, and no specimens were encountered before or after this time. The air temperature during this time fluctuated between 30–33 ºC. *Acanthodactylus ilgazi* **sp. nov.** lives in syntopy with the following reptile species: *Trapelus ruderatus* (Olivier, 1804), *Lacerta media* (Lantz & Cyren, 1920), *Ophisops elegans* (Menetries, 1832) and *Eumeces schneideri* (Daudin,1802).

Table 3. All mensural and meristic characters for three specimens of *Acanthodactylus ilgazi* **sp. nov.** from Yazıhan. Character abbreviations are listed in the Material and Methods section. The range and the mean of the mensural characters were calculated for the adult specimens only (i.e. for the holotype and paratype solely).

Characters	Holotype Adult female (ZDEU 2/2020-1)	Paratype Adult female (ZDEU 2/2020-2)	Paratype Juvenile (ZDEU 2/2020-3)	Range	Mean
SVL	77.40	73.60	40.60	73.60 – 77.40	75.50
TL	79.90	70.70	48.80	70.70 - 79.90	75.30
HW	13.14	12.33	7.38	12.33 - 13.14	12.74
HH	10.51	9.38	5.69	9.38 - 10.51	9.94
HL	16.71	14.66	9.72	14.66 - 16-71	15.65
PW	6.90	6.89	4.77	6.89 - 6.90	6.895
PL	13.78	11.67	9.63	11.67 - 13.78	12.65
FLL	22.40	20.80	11.80	20.80 - 22.40	21.6
HLL	38.70	35.80	21.90	35.80 - 38.70	37.25
AL	2.68	1.95	0.86	1.95 - 2.68	2.31
AW	4.41	3.18	2.54	3.18 - 4.41	3.8
SCGa	16	15	15	15 - 16	15.5
SCGb	15	16	14	14 - 16	15
LOa	2	2	2	2 - 2	2
LOb	2	2	2	2 - 2	2
SCPa	6	6	6	6 - 6	6
SCPb	7	6	7	6 - 7	6.5
SRLa	6	7	7	6 - 7	6.5
SRLb	7	7	7	7 - 7	7
SLPa	6	6	6	6 - 6	6
SLPb	6	6	7	6 - 7	6.5
IMa	5	5	5	5 - 5	5
IMb	5	5	5	5 - 5	5
MG	25	28	23	23 - 28	25.5
C	8	8	7	7 - 8	7.50
STa	2	2	2	2 - 2	2
STb	2	2	2	2 - 2	2
TVP	31	30	28	28 - 31	29.5
LVP	10	10	10	10 - 10	10
FPa	19	23	23	19 - 23	21
FPb	21	22	23	21 - 23	22
SDLa	21	21	21	21 - 21	21
SDLb	22	21	21	21 - 22	21.5
DS	48	49	50	48 - 50	49
PA1	1	1	1	1 - 1	1
PA2	4	5	5	4 - 5	4.5

Figure 5. General view of adult female paratype of *Acanthodactylus ilgazi* **sp. nov** (ZDEU 2/2020-2).

Figure 6. General view of juvenile paratype of *Acanthodactylus ilgazi* **sp. nov** (ZDEU 2/2020-3).

Figure 7. The type locality and habitat of *Acanthodactylus ilgazi* **sp. nov.** from Yazıhan, Malatya Province, Eastern Anatolia, Turkey.

Etymology

The name of the newly described taxon has been dedicated to Prof. Dr. Çetin Ilgaz honoring his long work on the herpetofauna biodiversity in Turkey.

Discussion

Our study focused on describing a new species of the genus *Acanthodactylus* from Turkey. The genus *Acanthodactylus* has been divided into nine morphological species groups, or ten according to genetic data (*micropholis, boskianus, yemenicus, tristrami, grandis, erythrurus, pardalis, scutellatus, blandfordi,* and *cantoris*) (Salvador, 1982; Arnold, 1983; Tamar et al., 2016). The *Acanthodactylus* species ranging in the Northern Middle East (Turkey, Lebanon, Syria, Northern Iraq) were suggested to members of the *boskianus*, *grandis*, and *tristrami* species groups (Salvador, 1982; Arnold, 1983; Tamar et al., 2016). Up to date, *Acanthodactylus* species distributed in Turkey are included within the *boskianus* (*A. boskianus* and *A. schreiberi*) and *grandis* (*A. harranensis*) species groups. In the present study, we assigned a new species within the *tristrami* species group, with its members distributed mostly in Syria, Jordan, and Iraq.

Acanthodactylus ilgazi **sp. nov.** shares many morphological characteristics with members of the *A. tristrami* species group: it is similar to *A. orientalis*, however, Haas & Werner (1969), stated that *A. orientalis* has three intact supraocular plates, and only the first plate was broken into two units, whereas *A. ilgazi* **sp. nov.** has only two supraocular plates. In addition, four rows of plaques on the finger, the reddish coloration of the underside of the tail, and the white or grayish stripe on the dorsum are important diagnostic characteristics that distinguish the new species from *A. orientalis*. *Acanthodactylus ilgazi* **sp. nov.** shares with *A. tristrami* several characters according to the morphological key in Salvador (1982): two supraoculars, one row of granules between supraoculars and supraciliaries, eyelids without pectination, large ear opening without anterior pectination, temporals granular and without keels, subocular in contact with the upper lip, four supralabials anterior to the subocular, smoot dorsal scales, and 10 straight longitudinal rows of ventrals. However, the most important diagnostic characteristics that differentiate *A. tristrami* from *Acanthodactylus ilgazi* **sp. nov.** are a higher count of dorsal scales, three rows of plates on the toes, unpectinated toes, and absence of reddish coloration under the tail**.**

The genus *Acanthodactylus* is phylogenetically divided into three major clades and 10 species groups (Tamar et al., 2016). According to the results of our phylogenetic tree, *Acanthodactylus ilgazi* **sp. nov.** is a member of the *tristrami* group. The new taxon differs from the other species of the group by a genetic distance of 13.03% from *A. orientalis*, 17.35% from *A. tristrami*, and 20.56% from the *A. robustus* (Table 2). Tamar et al. (2016) reported that divergence time between *A. orientalis* and *A. tristrami* was 8.2 million years ago. Although we have not calculated a divergence time within the scope of our study, it is clear that *Acanthodactylus ilgazi* **sp. nov.** diverged from the phylogenetic branch of *A. orientalis* and *A. tristrami* relatively earlier.

Anatolia hosts three globally known biodiversity hotspots: The Caucasus, Mediterranean, and Irano – Anatolian regions (Mittermeier et al., 2004). Although more than 80000 animal species live in this peninsula (Demirsoy, 2002), it is entirely covered by several eco-regional crises, such as habitat fragmentations in Central Anatolian steppes and Eastern Anatolian montane steppes (Hoekstra et al., 2005; Şekercioğlu et al., 2011). Therefore, it is such a deep misfortune that while taxonomic contributions to this geographic region are increasing day by day, the problematic environmental conditions are growing simultaneously, perhaps even faster than new discoveries. *Acanthodactylus ilgazi* **sp. nov.** has the same environmental problem in its habitat. According to preliminary expeditions, *Acanthodactylus ilgazi* **sp. nov.** is suggested to be distributed in an area of approximately 4 hectares. However, within this range, there is the Yazıhan dam-pond constructed by the State Water Affairs that might cause an obstacle for the expansion of the species in the area. Habitat loss, which is one of the key parameters for reptile population decline (Gibbons et al., 2000), might affect the current and future distribution of this species.

While describing a new species to the scientific world, one of the crucial issues is to support the description, especially if it is based on a relatively small sample size, using an integrative approach of molecular data and morphology. This approach has been taken into account in numerous studies (e.g., Patel & Vyas, 2020; Baptista et al., 2020; Rajabizadeh et al., 2020). Additionally, serious impact of scientific pressure on the over-collection of the species had been started to discuss for the conservation action (Hitchmough et al., 2016; Hope et al., 2018) and as a result of it, alternative strategies are suggested for the researchers, such as opportunistic sampling strategies (Bengil, 2020), sampling in larval stage (Mavruk, 2016), not lethal sampling (Hope et al, 2018). Moreover, we avoided over-collection of specimens, due to serious environmental concerns in the type locality of this new *Acanthodactylus* species.

Comparison with other *Acanthodactylus* species

In order to distinguish *Acanthodactylus ilgazi* **sp. nov.** from other *Acanthodactylus* species, we used the morphological data of previous studies on these species and created a key accordingly to literature (discrimination key at the end; Haas, 1957; Haas & Werner 1969; Salvador, 1982; Arnold, 1983; Geniez & Foucart, 1995; Baha El Din, 1996; Rastegar-Pouyani, 1998; Moravec et al., 1999; Meinig & Böhme, 2002; Werner, 2004; Baran et al., 2005; Heidari et al., 2013; Tamar et al., 2017; Miralles et al., 2020).

First, we divided all the defined species into two groups according to whether the subocular touches the mouth or not. Since the subocular plate of *Acanthodactylus ilgazi* **sp. nov.** touched the mouth, all other specimens (i.e. *A. robustus*) that had no mouth contact with the subocular plate were going to the number 15 in the key. The remaining 14 species were investigated via other characteristics in the discrimination key. In addition, we have given the comparison of some morphological characteristics between *Acanthodactylus* species in Table 1.

Discrimination key by using the descriptive characters of the *Acanthodactlus* species:

1. Subocular plates touched the mouth between 4th and 5th supralabials……………………………….2
1′. Subocular plates did not touch the mouth……………………………………………………………………15
2. One supraocular plates on the head…………………………………………………………………*A. boueti*
2′. Two or more supraocular plates on the head……………………………………………………………3
3. Three nasal plate surrounded the nostril………………………………………………………*A. guineensis*
3′. Two nasal plate surrounded the nostril…………………………………………………………………4
4. Temporal scales keeled…………………………………………………………………………*A. boskianus*
4′. Temporal scales unkeeled………………………………………………………………………………5
5. Two scales between prefrontals present………………………………………………………*A. savignyi*
5′. Two scales between prefrontals absent…………………………………………………………………6
6. Four supraoculars intact…………………………………………………………………………*A. masirae*
6′. Two or three supraoculars intact…………………………………………………………………………7
7. 2 supraoculars………………………………………………………………………………………………8
7′. 3 supraoculars……………………………………………………………………………………………11
8. Eyelids pectinated……………………………………………………………………………*A. micropholis*
8′. Eyelid unpectinated…………………………………………………………………………………………9
9. Keeled scales on upperside of tail……………………………………………………………*A. erythrurus*
9′. Unkeeled scales on upperside of tail……………………………………………………………………10
10. Dorsal scales above number of 51……………………………………………………………*A. tristrami*
10′. Dorsal scales below number of 51…………………………………………………***A. ilgazi* sp. nov.**
11. 4th toe strongly pectinated……………………………………………………………………*A. orientalis*
11′. 4th toe not strongly pectinated…………………………………………………………………………12
12. Ventrals arranged in 11 longitudinal rows………………………………………………… *A. ahmaddisii*
12′. Ventrals arranged between 8-14 longitudinal rows……………………………………………………13
13. Longitudinal rows of ventrals reached 14…………………………………………………… *A. beershebensis*
13′. Longitudinal rows of ventrals arranged between 8-12 ……………………………………………………14
14. Temporal scales smooth not keeled……………………………………………………………*A. lacrymae*
14′. Temporal scales smooth or slightly keeled…………………………………………………*A. montanus*
15. Subocular plates did not touched the mouth……………………………………………………*A. robustus*

AUTHOR CONTRIBUTIONS

Muammer Kurnaz and Mehmet Kürşat Şahin contributed equally to this work.

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