





Article

The Fergana Valley Is an Isolate of Biodiversity: A Discussion of the Endemic Herpetofauna and Description of Two New Species of *Alsophylax* (Sauria: Gekkonidae) from Eastern Uzbekistan

Roman A. Nazarov ^{1,*} , Timur V. Abduraupov ² , Evgeniya Yu. Shepelya ¹, Mariya A. Gritsina ², Daniel A. Melnikov ³, Matthew D. Buehler ⁴ , Jack D. Lapin ⁵, Nikolay A. Poyarkov ⁶  and Jesse L. Grismer ^{7,*}

¹ Zoological Museum, Lomonosov Moscow State University, B. Nikitskaya 2, 125009 Moscow, Russia; evgeniyashepelya@gmail.com

² Institute of Zoology Academy of Science of the Republic of Uzbekistan, Bagishamol Str., 232b, Tashkent 100053, Uzbekistan; timur.abduraupov@gmail.com (T.V.A.); mgritsina@gmail.com (M.A.G.)

³ Zoological Institute of the Russian Academy of Sciences, Universitetskaya nab. 1, 199034 St. Petersburg, Russia; melnikovda@yandex.ru

⁴ Department of Biological Sciences and Museum of Natural History, Auburn University, Auburn, AL 36849, USA; mbuehle3@gmail.com

⁵ Biodiversity Institute, Dyche Hall, University of Kansas, 1345 Jayhawk Blvd., Lawrence, KS 66045, USA; itsjacklapin@gmail.com

⁶ Faculty of Biology, Lomonosov Moscow State University, 119991 Moscow, Russia; n.poyarkov@gmail.com

⁷ Department of Biology, La Sierra University, Riverside, CA 92505, USA

* Correspondence: r_nazarov@mail.ru (R.A.N.); jgrismer@lasierra.edu (J.L.G.)



Citation: Nazarov, R.A.; Abduraupov, T.V.; Shepelya, E.Y.; Gritsina, M.A.; Melnikov, D.A.; Buehler, M.D.; Lapin, J.D.; Poyarkov, N.A.; Grismer, J.L. The Fergana Valley Is an Isolate of Biodiversity: A Discussion of the Endemic Herpetofauna and Description of Two New Species of *Alsophylax* (Sauria: Gekkonidae) from Eastern Uzbekistan. *Animals* **2023**, *13*, 2516. <https://doi.org/10.3390/ani13152516>

Academic Editors: Jianping Jiang, Bin Wang and Wei Zhu

Received: 14 June 2023

Revised: 25 July 2023

Accepted: 1 August 2023

Published: 4 August 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Simple Summary: This study was carried out in one of the most densely populated and geographically isolated regions in the Republic of Uzbekistan, the Fergana Valley. The Fergana Valley has the highest level of endemic biodiversity in Uzbekistan (and one of the highest in Central Asia), and the habitats of these endemic species are rapidly being developed for agricultural purposes. Given this development, the remaining areas of habitat are not being adequately protected. The main goal of this study was to obtain up-to-date data on the distribution and abundance of five endemic reptile species in the remaining isolated and undeveloped habitats across the Fergana Valley. One of the most important achievements was the discovery of two unique and new micro-endemic species of gecko genus *Alsophylax*, which are described herein. These results elevate the number of endemic species in the Fergana Valley and further highlight the urgent need to create state-protected areas of habitat with IUCN I and II protection status for the remaining areas of suitable habitat, which is currently not available.

Abstract: The high level of endemism in Fergana Valley has been well documented in numerous studies for various groups of animals and plants. In a relatively small area, there are 45 endemic plant species, five endemic insect species, and five endemic reptile species. In surveying this area for data on distribution, abundance, acoustics, and genetic samples for species of reptiles, we discovered two new species of gecko from the genus *Alsophylax*. Phylogenetic analyses of mitochondrial DNA sequences indicate the relatives of these new species are the even-fingered gecko, *Alsophylax pipiens*, and the southern even-fingered gecko, *Alsophylax laevis*, located hundreds of kilometers to the northwest and southwest of the Fergana Valley. The threats to these new endemic species are significant given the amount of continued agricultural development that involves new territories previously considered “unsuitable” for any species of significance that is leading to the further reduction in, fragmentation of, and degradation of the remaining natural ecosystems in the Fergana Valley. The conservation of these rare and locally endemic species depends directly on the readiness of the state to create areas with IUCN I and II protection. The many studies documenting levels of endemism, along with the data published in this study, are the basis for the justification for state-protected areas in the Fergana Valley.

Keywords: reptiles; conservation; taxonomy; Gekkonidae; *Alsophylax*; Fergana Valley; endemic species; cryptic diversity

1. Introduction

The Fergana Valley is located in the eastern region of Uzbekistan and represents an ancient, isolated ecoregion with unique flora and fauna, much of which is endemic to the valley. In a relatively small area, the Fergana Valley contains several dozen endemic plant species, five endemic species of insects, and five endemic reptile species, most of which are associated with the sandy massifs and foothill habitats in the western and southern areas [1]. With the level of aggressive agricultural development and effects associated with climate change, each of these endemic species is facing its own set of environmental threats. For example, Strauch's toad agama (*Phrynocephalus strauchi* Nikolsky, 1899), Said-Aliev's toad-head agama (*Phrynocephalus saidalievi* Sattorov, 1981), Fergana sand racerunner (*Eremias scripta pherganensis* Szczerbak et Washetko, 1973), and Strauch's even-fingered gecko (*Alsophylax loricatus* Strauch, 1887) are all sandy massif specialists, and all five species fall into the "risk zone" [2]. These historically undisturbed sandy massifs, which comprise one of the key habitats for endemic species of reptiles in the Fergana Valley, have been reduced to 175.71 sq. km, and there are currently only 13 isolated plots of habitat, which now occupy an area of 0.46–58.66 sq. km [3].

1.1. The Current Status of Conservation in Fergana Valley

Agriculture and textile development has a long history in the Fergana Valley causing the gradual reduction in native habitats. The greatest reduction occurred in the early 20th century due to textiles and vegetable farming, leading to the development of the flatter areas such as sandy habitats. These sandy habitats represent the remains of a vast desert complex in the Fergana Valley originating from the Syrdarya River and are quite old, allowing for adaptation and speciation in these unique microhabitats. The rapid growth of the population of Uzbekistan [3] led to large portions of these habitats being plowed for development. Simultaneously, the rise in population also led to the construction of many agricultural fields, fish ponds, and houses, further fragmenting sandy habitats into sand islands, and preventing migration between adjacent populations. Additionally, excessive watering of adjacent agricultural developments has had a negative impact on existing habitat, resulting in a change to the hydrological regime [3]. This increase in groundwater creates more vegetation growth in these sand habitats, reducing the open cover dune habitat. This reduction in open dune habitat increases interspecific competition between the endemic sand-dune-adapted species and surrounding non-sand-dune-adapted species, making conservation efforts ineffective [4,5]. The problem of preserving sand massif habitats in the Fergana Valley is further complicated by the fact that establishing the correct status and protection regime for these unprotected areas in Uzbekistan is technically quite difficult.

Until 2023, conservation of these endemic reptile species and their habitats was hampered by the fact that, in the Fergana Valley, there were no pre-existing areas with IUCN I and II protection status. The existing natural state monument, "Yazyavan sands" [1,2], and other natural district-level monuments do not meet the requirement for higher-level biodiversity conservation [6]. However, since 2020, the project "Preservation of Key Natural Complexes in the Fergana Valley (Republic of Uzbekistan)" through the Michael Succow Foundation, with support from the World Wildlife Fund (WWF), Critical Ecosystem Partnership Fund (CEPF), and Central Asian Desert Initiative (CADI) project, has been garnering more attention for the conservation of the Fergana Valley. Additionally, the project "Maintenance and Conducting Selective Records of Rare and Endangered Species of Vertebrate Animals of the Fergana Valley", carried out by the "Cadaster and Cadastre of Rare Vertebrate Animals" at the Institute of Zoology of the Academy of Sciences of the

Republic of Uzbekistan, has been documenting new populations of species in the Fergana Valley since 2020. In 2019, our team conducted a National Geographic Explorers expedition to survey reptiles in Uzbekistan including the Fergana Valley, and our team returned for multiple expeditions in the Fergana Valley between late 2019 and late 2022. Our team assessed the current state of the remaining preserved isolated habitat sites; as a result, we were able to update distribution and population density data for many reptile species in Uzbekistan. Most of our surveys were focused on the endemic and endangered species in Fergana Valley. Moreover, during these surveys, we discovered two new micro-endemic habitat specialist species of the small body-sized gekkonid genus, *Alsophylax*.

1.2. Current Taxonomy of the Gecko Genus *Alsophylax*

Alsophylax Fitzinger, 1843 originated from the description of *Lacerta pipiens* by Pallas [7] and was subsequently placed in its own genus, *Alsophylax*, by Fitzinger [8]. Since then, *Alsophylax* has received little attention due to the fact that its species are very small in size and have what can be perceived as a conserved morphology across the distribution of the genus. As a result, the taxonomic history of this group has been extremely complicated and confounding. Fortunately, there have been detailed descriptions of useful characteristics for describing new species in recent works [1,9–11]. Currently, *Alsophylax* comprises six species distributed in Central Asia and southern Russia (*A. laevis* Nikolsky, 1907; *A. loricatus* Strauch, 1887; *A. pipiens* (Pallas, 1827); *A. przewalskii* Strauch, 1887; *A. szczerbaki* (Golubev & Sattarov, 1979); *A. tadjikiensis* Golubev, 1979) [1]. To date, no study has investigated the interspecific relationships within *Alsophylax*, and even its phylogenetic position among other gecko genera remains poorly understood, further exemplifying their understudied nature [12–14].

In this study, we provide the most complete phylogeny for *Alsophylax* on the basis of the mitochondrial barcoding gene cytochrome oxidase I, and we include expanded sampling for species complexes such as *A. laevis* and *A. pipiens*. We used this phylogeny along with a dataset of morphological characteristics to demonstrate that these new populations of *Alsophylax* from the Fergana Valley are distinct species and clearly demonstrate the need for further work in Uzbekistan and the Fergana Valley to find other undescribed *Alsophylax* species. Lastly, we provide a discussion on the history of herpetological work in the Fergana Valley, highlighting its endemic reptile species and providing updated distribution and population density assessments of these endemic reptiles.

2. Materials and Methods

2.1. Population Density and Field Observations

We sampled individuals using the line transect survey method at each sand massif habitat island. During the field observations, we observed 1288 individuals of seven species along the total route length of 210 km. Diurnal species were estimated from routes with varying width along the transect. We recorded the perpendicular distance from the transect line to each individual reptile that was recorded to calculate the transect width. We carried out nocturnal sampling using headlamps at a fixed width along the transect. When surveying *Teratoscincus*, we also used the counting of the reddish eye reflections with some specimens detectable at quite far distances up to 100 m or more. However, we understand that using a wide census band can underestimate occurrence data. Therefore, we limited it in accordance with the terrain and vegetation cover of the area. The accounting results, average detection distance (\bar{y}) of the species and effective width of the census band (B), were calculated. We calculated population density (D) per hectare (ha) using the following formula:

$$D = \frac{N}{2BL}; B = \frac{\pi}{2} \bar{y}; \bar{y} = \frac{1}{n} \sum_{i=1}^n y_i,$$

where N is the total number of individual reptiles, n is the number of individuals with measured detection distances, and L is the route length. Comparative analysis of the results obtained using various route accounting methods proved its high accuracy [15].

This method has been successfully employed in multiple studies to survey desert reptile species [16–18]. We calculated mean values of the population density along with estimation of their error ($M \pm m$) according to the results at several approximately equal route sections.

We conducted daytime surveys in sunny weather with low wind and no precipitation. We started recording data coinciding with the lizards' maximum activity, and finished when they shifted to shelters to escape the heat during the maximum daytime temperature. We also recorded substrate temperature.

2.2. Molecular Data and Phylogenetic Analyses

Our dataset included 46 samples belonging to all six *Alsophylax* species, including the two new species from the Fergana Valley. This also includes one *Altiphylax* species from Central Asia, which we hypothesize is an *Alsophylax*, and one sample of *Mediodactylus kirmanensis* (Nikolsky, 1900) from southern Iran as an outgroup. All analyzed materials are listed in Appendix A.

We extracted total genomic DNA from ethanol-preserved muscle or liver tissues using standard phenol–chloroform extraction procedures [19] followed by isopropanol precipitation. We amplified a fragment of the cytochrome oxidase I (COI) gene with maximal length of 655 bp. This mitochondrial marker is widely used for barcoding in vertebrates [20,21] and has also proven to be useful for species identification in reptiles [22–24]. Primers used both for PCR and sequencing were the VF1-d (5'-TTC TCA ACC AAC CAC AAR GAY ATY GG-3'), VR1-d (5'-TAG ACT TCT GGG TGG CCR AAR AAY CA-3') [25], RepCOI-F (5'-TNT TMT CAA CNA ACC ACA AAG A-3'), and RepCOI-R (5'-ACT TCT GGR TGK CCA AAR AAT CA-3') [24]. We sequenced fragments in both directions for each sample, and a consensus sequence was generated. We used 25 µL reactions for PCRs with approximately 50 ng of genomic DNA, 10 pmol of each primer, 15 nmol of each dNTP, 50 nmol of additional MgCl₂, Taq PCR buffer (10 mM Tris-HCl, pH 8.3, 50 mM KCl, 1.1 mM MgCl₂, and 0.01% gelatine), and 1 U of Taq DNA polymerase. We used the following PCR conditions: an initial denaturation step at 95 °C for 3 min; five cycles at 95 °C for 30 s, annealing at 45 °C for 1 min, and extension at 72 °C for 2 min; 35 cycles at 95 °C for 30 s, annealing at 48–51 °C for 1 min, extension at 72 °C for 2 min, final extension of 5 min at 72 °C, and storage at 4 °C. We loaded PCR products onto 1% agarose gels, stained with GelStar gel stain (Cambrex), and visualized in a Dark reader transilluminator (Clare Chemical). If results were satisfactory, products were purified using 2 µL, from a 1:4 dilution of ExoSapIt (Amersham), per 5 µL of PCR product prior to cycle sequencing. The 10 µL sequencing reaction included 2 µL of template, 2.5 µL of sequencing buffer, 0.8 µL of 10 pmol primer, 0.4 µL of BigDye Terminator version 3.1 Sequencing Standard (Applied Biosystems), and 4.2 µL of water. The sequencing reaction was 35 cycles of 10 s at 96 °C, 10 s at 50 °C, and 4 min at 60 °C. We purified cycle sequencing products using ethanol precipitation. We carried out sequence data collection and visualization on an ABI 3730xl automated sequencer (Applied Biosystems). Resulting sequences are deposited in GenBank under accession numbers (see Appendix A).

All Sequences were aligned manually using BioEdit Sequence Alignment Editor 5.0.9 [26]. The final alignment used for all phylogenetic analysis contained 654 bp of COI gene for all samples. MODELTEST v.3.06 [27] was used to estimate the optimal evolutionary models to be used for phylogenetic analysis. The preferred model was (GTR + G), as suggested by the Akaike information criterion (AIC). Confidence in tree topology was estimated with bootstraps in RAXML 8.1.1 [28]. We considered values above 85% as strong support and rather than choose an arbitrary number of bootstrap replicates to run we use internal metrics of the to allow the analysis to stop itself when sufficient replicates have been run.

2.3. Morphological Data and Statistical Analyses

We analyzed 310 specimens of all six recognized species of the genus *Alsophylax* for 22 morphological characteristics, including 14 metric and eight meristic characteristics. We chose these morphological characters on the basis of previous studies on *Alsophylax* [9], as well as additional new characteristics that were identified for this study. All specimens used were from Zoological Museum of Moscow State University (ZMMU), Zoological Institute of St. Petersburg (ZISP), Institute of Zoology National Academy of Science, Ukraine (IZ NAS), and Institute of Zoology Academy of Sciences of the Republic of Uzbekistan (IZ) (Appendix A).

Morphological measurements were taken with a digital caliper to the nearest 0.1 mm and included the following list of characteristics (14 in total): snout–vent length (SVL) measured from tip of snout to vent; tail length (TL), measured from vent to tail tip; head length (HL), distance between retroarticular process of jaw and snout tip; head width (HW), measured at the widest point of the head; head height (HeadH), measured from top of occiput to underside of jaws; orbital diameter (OrbD), diameter of orbit; snout-to-eye distance (SnEye), measured between anterior most point of eye and tip of snout; eye-to-ear distance (EyeEar), distance from anterior edge of ear opening to posterior corner of eye; humeral length (LS), measured on ventral surface of arm from base of axilla to posterior margin of elbow while forelimb bent by 90° at elbow; forearm length (ForeaL), measured on dorsal surface while forelimb bent by 90° at the elbow from the posterior margin of elbow to wrist; femur length (FemurL), measured on the ventral surface of the leg from base of femur to knee while hindlimb bent by 90°; crus length or tibia length (CrusL), measured on ventral surface of the of knee to the base of the heel while hindlimb bent by 90°; length of finger IV (LD4A), length of free distal phalanx of forth finger, without claw; length of toe IV (LD4P), length of free distal phalanx of forth toe, without claw.

The following characteristics (eight in total) were examined: number of scales around midbody including ventral and dorsal scales (Sq); number of scales along midbody from mental shield to anterior edge of cloaca (SLB); number of supralabials (SL); number of infralabials (IL); number of scales along middle of head, between eyes (I); number of subdigital lamellae under fourth finger (LF 4); number of subdigital lamellae under fourth toe (LT 4); number of postcloacal spurs on base of tail on both sides (Spurs); number of precloacal pores (PP).

We investigated morphometric differences between species of *Alsophylax* and the new species described herein. We log₁₀-transformed all meristic measurements to normalize the data normality and increase the homogeneity of variance. We adjusted morphometric measurements to remove the effects of body size variation [29]. We use the allometric formula: $X_{adj} = \log(X) - b[\log(BL) - \log(BL_{mean})]$. We conducted a discriminant function analysis (DFA) to characterize the morphological variation between one new population of *Alsophylax* from the Fergana Valley and *A. laevis* and *A. pipiens*.

3. Results

3.1. Population Density and Distribution

Through literary sources, as well as the results of our surveys of the Fergana Valley from 2019 to 2022, we noted 27 species of reptiles, which accounts for 43.5% of all reptile species known from Uzbekistan. Eight (30%) of the 27 Fergana Valley species are considered rare and listed in the Red Book of the Republic of Uzbekistan, five species (18.5%) are listed in the IUCN Red List, and three (11%) are CITES-protected species. Lastly, there are seven (26%) species that are micro-endemic species. The data from our surveys were analyzed and used to make Table 1, which lists all surveyed locations with an estimated average density of each endemic reptile species.

Table 1. Density of rare and endemic retille species in key locations of the Fergana Valley.

Survey Point Number	<i>Alsophylax ferganensis</i> sp. nov.	<i>Alsophylax emilia</i> sp. nov.	<i>Alsophylax loricatus</i>	<i>Teratoscincus rustamowi</i> (Szczerbak, 1979)	<i>Phrynocephalus helioscopus saidalievi</i> (Sattorov, 1981)	<i>Phrynocephalus strauchi</i>	<i>Eremias scripta pherganensis</i>
1	5.25	-	-	-	0.1	-	-
2	-	-	11	-	-	-	-
3	-	-	-	54	-	6.8	7.7
4	-	-	-	25.3	-	3.2	6.8
5	-	-	-	58.5	-	-	9.6
6	-	-	-	36.3	-	2.4	2.7
7	-	-	-	-	2.3	-	-
8	-	3.4	-	-	3.4	-	-
9	-	4.5	-	-	4.2	-	-
10	-	-	-	-	3.7	-	-
11	-	-	-	-	4.1	1.6	-
12	-	-	-	14.7	-	3	-

1—Shorsu foothills (N40.24625; E70.81362); 2—fortress in Sary-Kurgan village (N40.334791; E71.021476); 3—Mingbulak Natural Monument (N40.77548; E71.35531); 4—Yazyavan Natural Monument (N40.716225; E71.487536); 5—sandy massif near Katta-Turk village (N40.63035; E70.81481); 6—sandy massif and clay uplands of Kairakum (N40.44350; E70.41715); 7—vicinity of the Altyaryk village (N40.355251; E71.591541); 8—pap foothills, 10 km northwest of Turakurgan village (N41.067757; E71.412176); 9—pap foothills, Jidalisai (N40.891349; E70.884367); 10—pap foothills, Uygursay (N40.95126; E71.01833); 11—pap foothills, 6 km south of Khanabad village (N40.831743; E70.736846); 12—vicinity of the Dangara village (N40.651748; E70.875879).

3.2. Molecular Analysis and Morphology

All phylogenetic analyses support the monophyly of *Alsophylax* (Figure 1). These analyses demonstrate that both *A. pipiens* and *A. laevis* are polyphyletic, with significant genetic structure within each of these wide-ranging species complexes. These analyses also indicate that both of these new *Alsophylax* populations from the Fergana Valley (Figure 2) are represent unique evolutionary lineages, sister to different clades of either *A. pipiens* or *A. laevis*. All sequences have been deposited on Genbank and their accession number can be found in Appendix B.

Taxonomy

Family Gekkonidae

Genus *Alsophylax* Fitzinger, 1843

Both new species belong to the genus *Alsophylax* according to the following morphological characteristics:

(1) Elongate body with relatively short limbs; (2) non-segmented tail approximately the same length as the body; (3) relatively small and roundish head with a short rostral part; (4) no femoral pores and 6–8 precloacal pores; (5) small, roundish and flattened dorsal tubercles are present in some representatives of this genus, or dorsal scales can be smooth and homogeneous in another species.

Alsophylax ferganensis sp. nov. (Figures 3 and 4a).

Holotype. Adult male ZMMU Re-17532 (field ID RAN 4358) collected from urban-type settlement Shorssu (N 40.244792 E 70.821582), Uzbekistan District, Fergana Region, Uzbekistan by Timur Abduraupov and Roman Nazarov in 2021 (Figure 5a–e).

Paratypes. Four males UZZI RE-19077, UZZI RE-19078, ZMMU Re-17537, ZMMU Re-17538 (field ID RAN 4360, RAN 4363, RAN 4370, RAN 4371) and seven females UZZI RE-19075, UZZI RE-19076, Re-17533, Re-17534, Re-17535, Re-17536, Re-17539 (field ID RAN 4359, 4361, 4362, 4364, 4365, 4369, 4372) data same as the holotype (Figure 5f, Table 2).

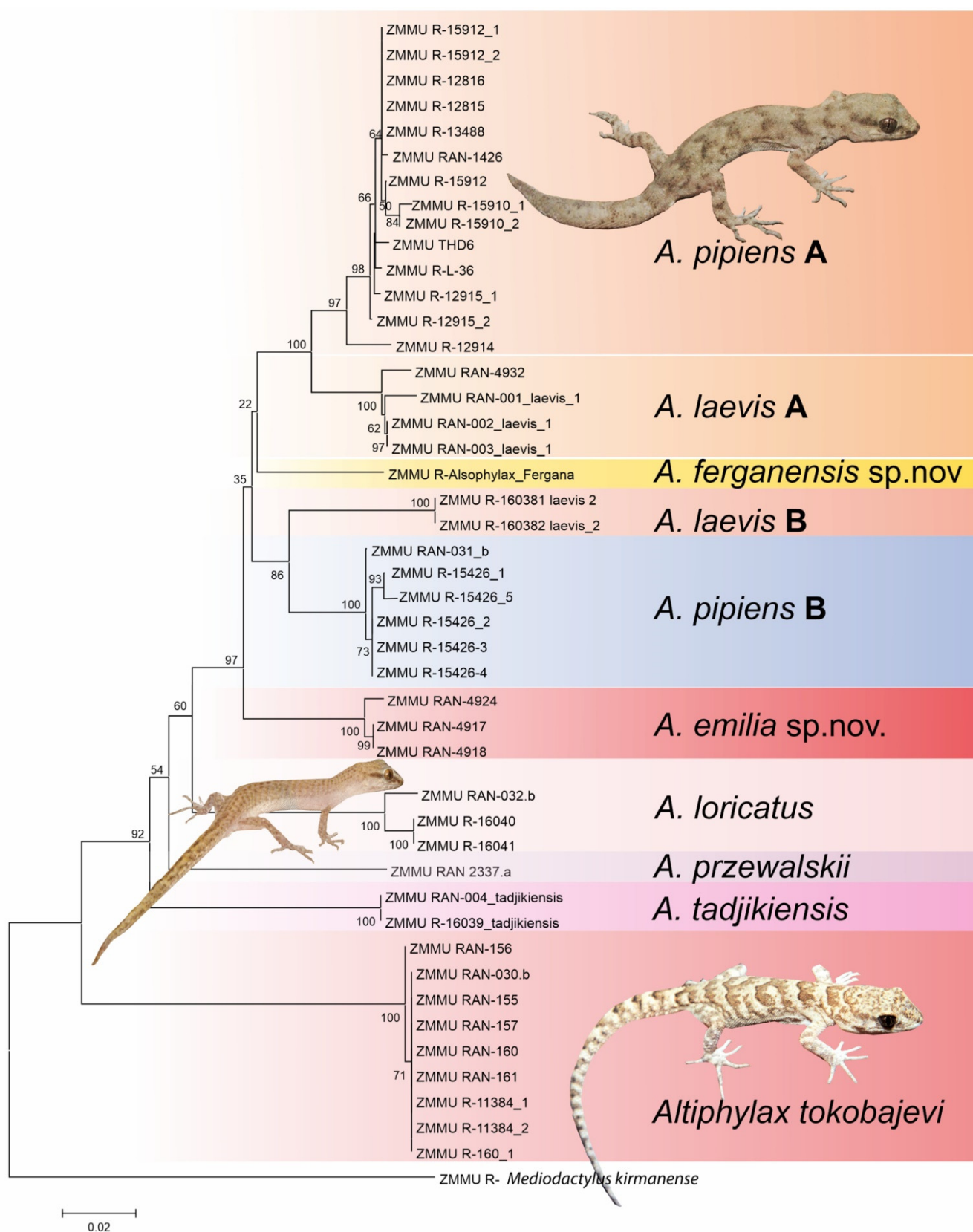


Figure 1. The gene tree from the maximum likelihood analysis for all described *Alsophylax* species using cytochrome oxidase I (COI).

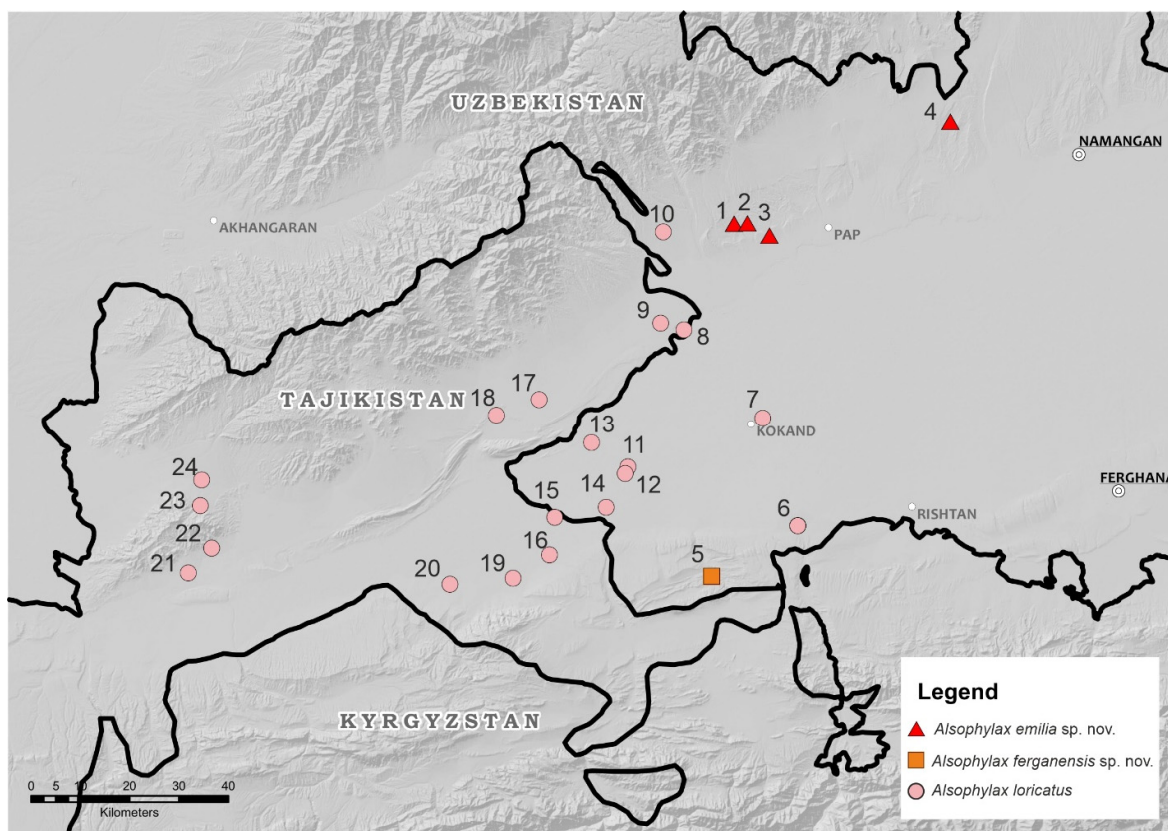


Figure 2. Distribution of three species of *Alsophylax* in the Fergana Valley.

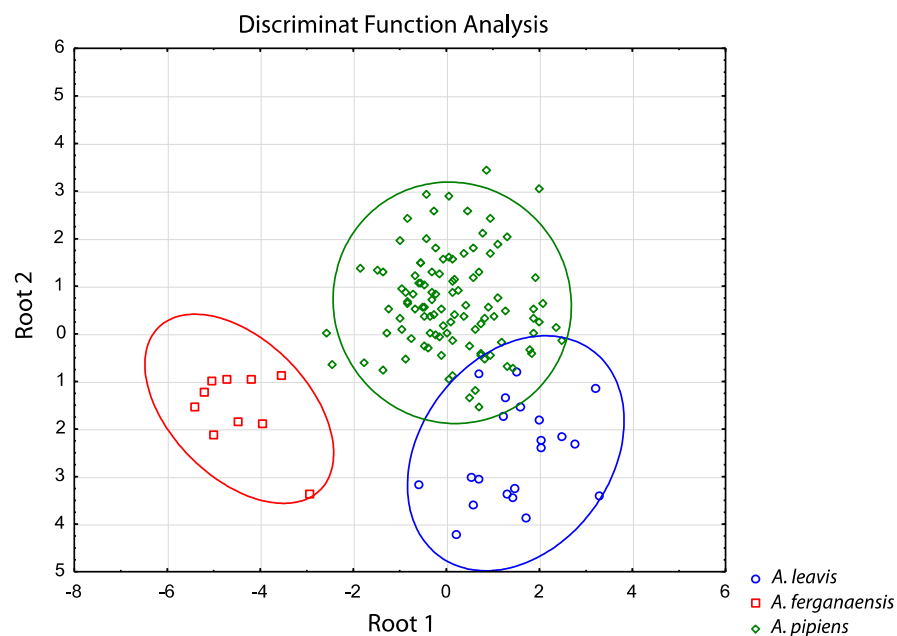


Figure 3. A plot from the discriminant function analysis for *Alsophylax laevis*, *A. pipiens*, and *A. ferganensis* sp. nov. The results of our discriminant function analysis demonstrate that *Alsophylax ferganensis* sp. nov. is morphometrically distinct from all clades of *A. laevis* and *A. pipiens*. Given the low sample size for *A. emilia* ($n = 3$), we were not able to make meaningful statistical comparisons with other species.

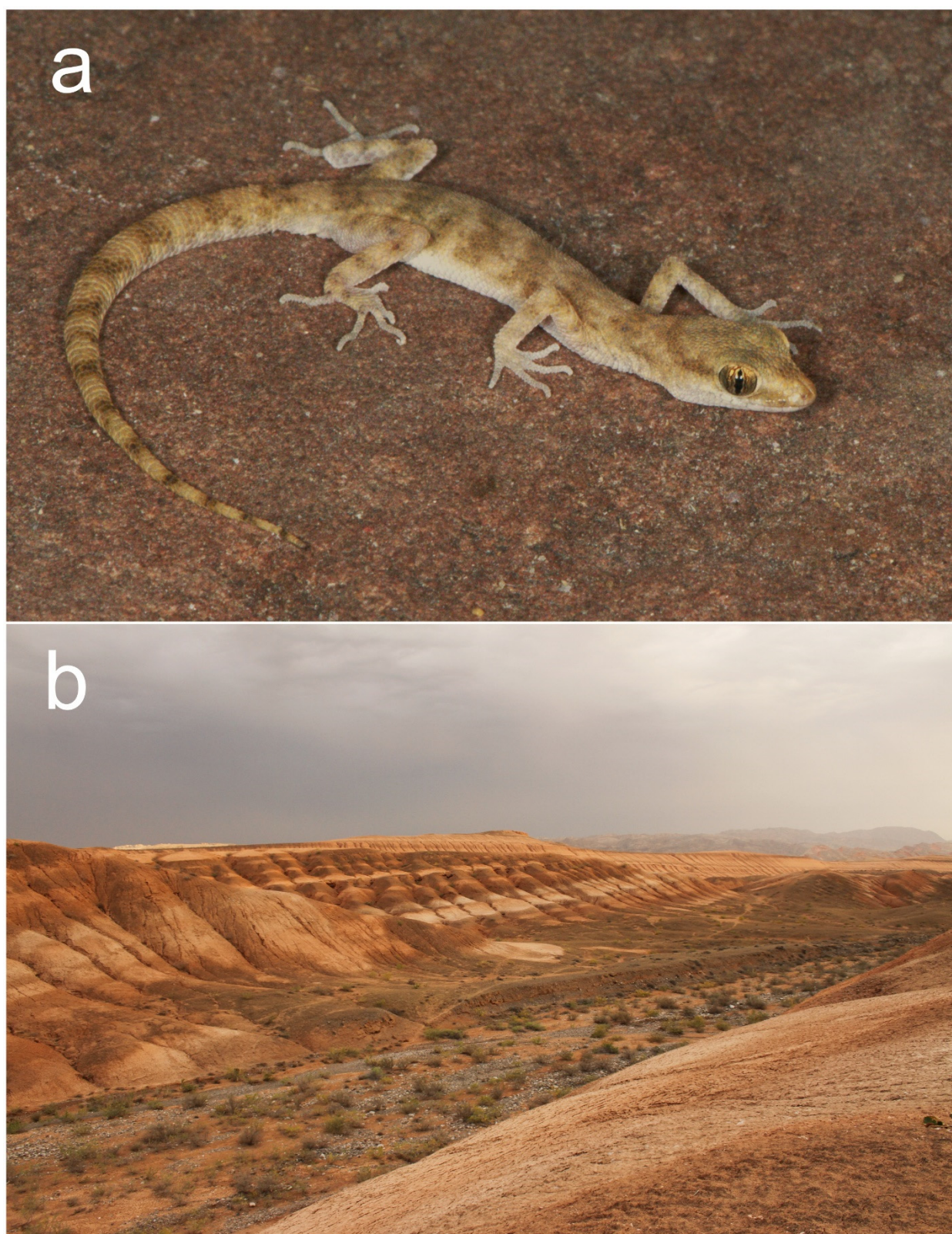


Figure 4. (a) *Alsophylax ferganensis* sp. nov. sp. nov. in situ and (b) its habitat.

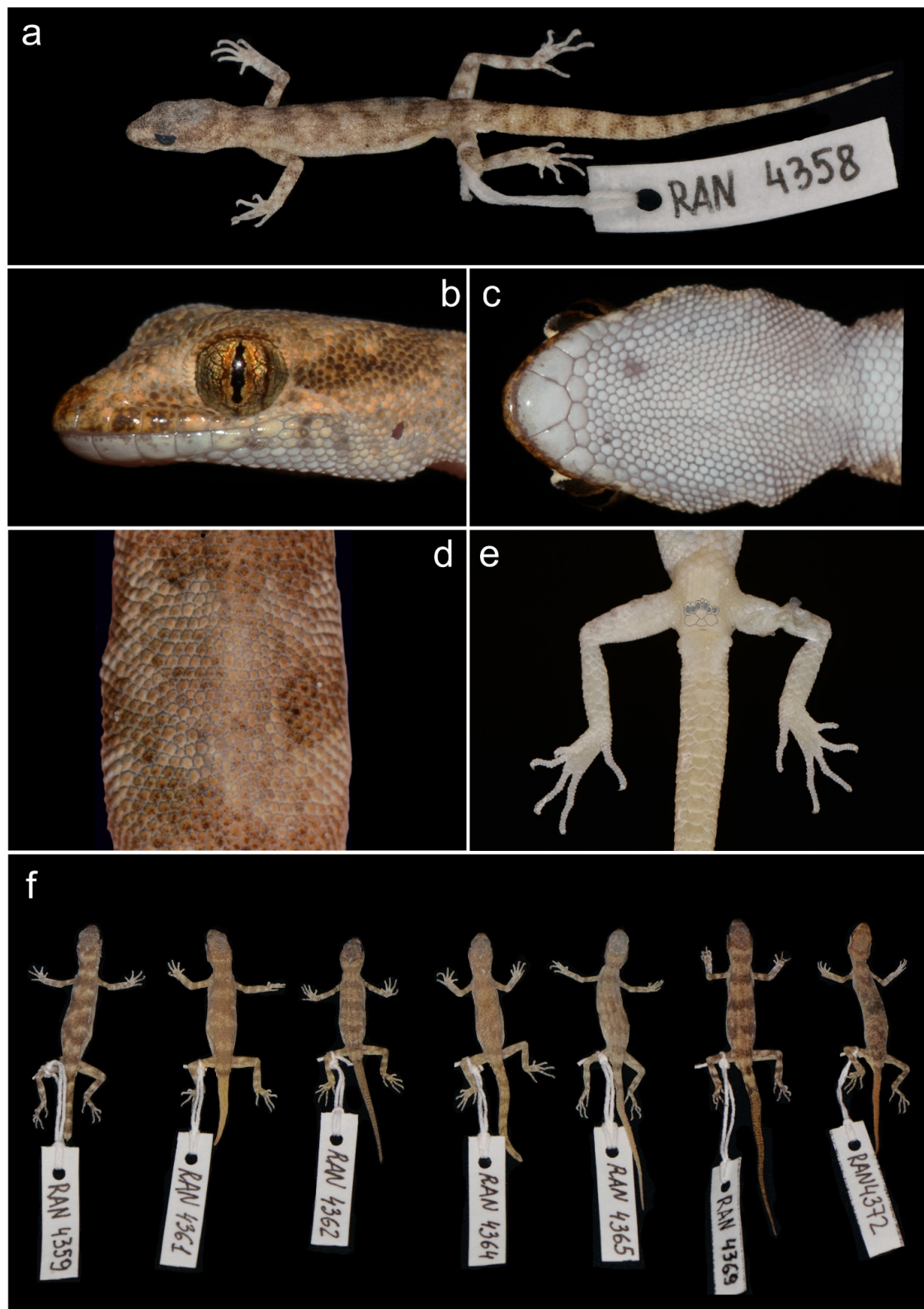


Figure 5. Holotype of *Alsophylax ferganensis* sp. nov. ZMMU Re-17532: (a) general view of preserved specimens; (b) lateral view of the head; (c) gular region showing mental, postmental, and chin scale arrangement; (d) middle of the back with homogeneous dorsal scales; (e) precloacal region showing pore and spur arrangements, and plantar view of feet showing subdigital lamellae; (f) general view of part of the paratype series of *A. ferganensis* sp. nov.

Table 2. Measurements of the type series of *Alsophylax ferganensis* sp. nov.

	<i>Holotype</i>				<i>Paratypes</i>							
	ZMMU Re-17532	UZZI RE-19075	UZZI RE-19077	UZZI RE-19076	ZMMU Re-17533	UZZI RE-19078	ZMMU Re-17534	ZMMU Re-17535	ZMMU Re-17536	ZMMU Re-17537	ZMMU Re-17538	ZMMU Re-17539
<i>Field No.</i>	RAN 4358	RAN 4359	RAN 4360	RAN 4361	RAN 4362	RAN 4363	RAN 4364	RAN 4365	RAN 4369	RAN 4370	RAN 4371	RAN 4372
<i>SEX</i>	m	f	m	f	f	m	f	f	f	m	m	f
<i>SVL</i>	29.6	31.5	28.5	29.3	24.9	27.7	27.2	28.8	30.3	30	25.2	29
<i>TL</i>	36.9	-	29.6	-	-	-	-	28.7	32.9	37.7	32.1	23.7
<i>HL</i>	8.1	7.9	8	7.8	8	7.4	7.6	7.2	7.8	7.9	7	7.9
<i>HW</i>	4.6	4	4.2	3.9	3.5	4	4	3.8	4	3.9	3.5	3.7
<i>HH</i>	2.7	2.8	3	2.5	2.5	2.3	2.5	2.6	2.4	2.5	2	2
<i>SnEye</i>	3	2.7	2.7	2.6	2.3	2.7	2.5	2.4	2.5	2.5	2.4	2.4
<i>EyeEar</i>	2.7	2.2	2.4	2.6	2.1	2.1	2.4	2.2	2.4	2.5	2.1	2.2
<i>Orb D</i>	2	2	1.8	1.9	1.6	1.6	1.8	1.8	1.8	1.9	1.7	1.9
<i>LS</i>	4.7	4.3	4.6	4.5	4.4	4.4	4.6	4.6	4.7	4.3	4.2	4.5
<i>ForeaL</i>	4.3	4	4	3.8	3.5	3.8	3.9	4	4.1	3.8	3.5	3.9
<i>FemurL</i>	5.9	5.3	5.9	5.8	5.4	5.5	5.3	5.4	5.7	5.3	5.4	5.3
<i>CrusL</i>	5.9	5.6	5.6	5.5	4.9	5.1	5.2	5.1	6	5	5	5.6
<i>LD4A</i>	2.3	2.1	1.8	2.1	2.3	2.4	2.2	2.3	1.9	2.5	2.1	2.3
<i>LD4P</i>	3.1	3	2.7	3.1	3.2	2.9	3.1	3	2.8	3.3	2.9	3.3
<i>SL (r/l)</i>	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/8	7/8	7/7	8/6	7/7
<i>IL (r/l)</i>	5/5	5/6	5/5	5/5	5/5	5/5	5/5	6/6	5/6	5/5	6/5	5/5
<i>SEH</i>	18	18	22	21	20	19	18	20	19	19	20	19
<i>LF4</i>	14	14	14	15	15	13	13	15	13	13	12	14
<i>LT4</i>	18	15	16	15	14	15	15	17	16	14	15	18
<i>SLB</i>	86	87	86	83	89	88	89	97	85	84	94	94
<i>PP</i>	7	-	6	7	-	6	7	8	7	6	7	7
<i>Spurs (r/l)</i>	2/2	3/3	3/2	2/3	3/3	3/3	2/2	3/3	3/3	3/3	2/2	2/2
<i>Sq</i>	44	48	50	49	44	45	47	47	47	48	47	51

Diagnosis. *Alsophylax ferganensis* sp. nov. is tentatively a sister to clades A of *A. pipiens* and *A. laevis* (Figure 1) and morphologically closer to *A. laevis* (Table 3). *Alsophylax ferganensis* sp. nov. sp. nov. can be distinguished from *A. laevis* by a smaller maximum body size (SVL_{max} 31.5 mm versus 38.7 mm) and relatively narrow head, as well as elongated limbs and dorsal patterns with well-defined nuchal loop, and relatively narrower dark transverse bands with approximately equal interspaces in between versus wide transverse patterns and narrow interspaces in *A. laevis* (Figure 6). Caudal margins have dark transverse bands that are wavy. Dorsal scales are flat, smooth, and roundish, without enlarged dorsal tubercles (Figure 7).

Table 3. Morphological characteristics and data used in this study.

	<i>Alsophylax</i> <i>cf. laevis</i>	<i>Alsophylax</i> <i>laevis</i>	<i>Alsophylax</i> <i>loricatus</i>	<i>Alsophylax</i> <i>pipiens</i>	<i>Alsophylax</i> <i>cf. pipiens</i>	<i>Alsophylax</i> <i>przewalskii</i>	<i>Alsophylax</i> <i>szczyrbaki</i>	<i>Alsophylax</i> <i>tadjikiensis</i>	<i>Alsophylax</i> <i>ferganensis</i>
N	21	60	25	46	107	19	17	3	12
SVL									
mean	31.97	32.55	30.74	33.14	32.00	30.35	28.26	27.10	28.50
±SD	1.65	2.34	3.02	3.06	2.47	1.58	1.27	2.07	1.50
range	27.2–35.2	26.6–38.7	24.6–40.9	27.4–41.5	26.2–39.8	26.59–33.5	26.3–32.4	24–29.1	24.9–31.5
TL									
mean	31.10	33.96	35.91	33.68	32.57	38.18	33.31	25.30	30.43
±SDSD	4.13	2.74	3.60	2.69	3.53	3.81	3.56	0.00	2.98
range	24–42.6	25–42	27.5–44.6	23.3–43.5	19–42.8	31.19–45.3	23.7–42.3	25.30	23.7–37.7
HL									
mean	8.86	8.87	8.32	9.07	8.89	8.37	7.98	7.53	7.72
±SDSD	0.44	0.55	0.91	0.79	0.63	0.32	0.30	0.49	0.28
range	7.9–9.7	7.4–10.3	7–10.7	7.5–10.9	7.2–11	7.02–8.93	7.3–8.8	6.8–8	7–8.1
HW									
mean	5.02	4.94	4.44	5.12	5.14	4.82	4.24	3.90	3.93
±SD	0.32	0.36	0.48	0.52	0.45	0.38	0.20	0.13	0.21
range	4.4–5.7	3.9–5.9	3.6–5.7	3.6–6.7	4–6.5	4.2–5.8	3.7–4.7	3.7–3.9	3.5–4.6
HH									
mean	3.18	3.06	2.70	3.31	3.32	3.36	2.69	2.50	2.48
±SD	0.32	0.28	0.32	0.35	0.36	0.41	0.16	0.13	0.21
range	2.3–4.2	2.4–4.2	2–3.51	2.2–4.1	2.2–4.5	2.5–4.33	2.2–3	2.7–2.4	2–3
SnEye									
mean	2.92	2.86	2.80	2.98	2.91	2.74	2.52	2.43	2.56
±SD	0.22	0.18	0.30	0.30	0.22	0.15	0.09	0.09	0.15
range	2.5–3.4	2.3–3.4	2.3–3.6	2.4–3.8	2.4–3.6	2.19–3	2.3–2.7	2.3–2.5	2.3–3
Orb D									
mean	2.18	2.05	1.82	2.15	2.15	1.72	1.74	1.80	1.82
±SD	0.15	0.11	0.29	0.18	0.17	0.23	0.08	0.20	0.10
range	1.9–2.6	1.6–2.5	1.26–2.7	1.69–2.8	1.6–2.7	1.18–2	1.5–1.9	1.5–2.1	1.6–2
LS									
mean	5.11	4.70	4.40	4.93	4.72	4.39	3.83	3.93	4.48
±SD	0.40	0.31	0.70	0.53	0.40	0.33	0.13	0.16	0.14
range	4.2–6.7	3.6–5.3	3.5–6	3.8–6.2	3.6–6.4	3.52–5	3.5–4.2	3.7–4	4.2–4.7

Table 3. Cont.

	<i>Alsophylax</i> <i>cf. laevis</i>	<i>Alsophylax</i> <i>laevis</i>	<i>Alsophylax</i> <i>loricatus</i>	<i>Alsophylax</i> <i>pipiens</i>	<i>Alsophylax</i> <i>cf. pipiens</i>	<i>Alsophylax</i> <i>przewalskii</i>	<i>Alsophylax</i> <i>szczerbaki</i>	<i>Alsophylax</i> <i>tadjikiensis</i>	<i>Alsophylax</i> <i>ferganensis</i>
ForeaL									
mean	4.40	3.85	3.49	4.15	4.00	3.51	3.15	3.37	3.88
±SD	0.29	0.26	0.59	0.45	0.31	0.27	0.14	0.18	0.17
range	3.8–5.6	3–4.7	2.7–5	3–5.5	2.9–5	3.1–4.11	3–3.4	3.1–3.4	3.5–4.3
FemurL									
mean	5.89	5.29	5.19	5.91	5.74	5.17	4.45	4.53	5.52
±SD	0.35	0.32	0.74	0.65	0.44	0.29	0.22	0.11	0.21
range	5.2–6.6	4.2–6.1	4–7.2	4.4–7.9	4.5–7.3	4.5–5.71	4.1–5.2	4.7–4.4	5.3–5.9
CrusL									
mean	5.70	5.22	4.73	5.60	5.27	4.84	4.31	4.50	5.38
±SD	0.34	0.36	0.80	0.57	0.48	0.34	0.18	0.07	0.33
range	5–6.5	4–6	3.6–6.8	4.3–7.1	3.9–6.7	4.1–5.49	3.9–4.7	4.4–4.5	4.9–6
LD4A									
mean	2.20	2.21	2.52	2.76	2.81	2.50	2.26	1.90	2.19
±SD	0.17	0.17	0.40	0.31	0.26	0.18	0.21	0.07	0.16
range	1.9–2.6	1.8–2.7	1.8–3.6	2.1–3.6	2–3.5	2.1–2.9	1.5–2.8	1.9–1.8	1.8–2.5
LD4P									
mean	2.97	2.92	3.45	3.67	3.58	3.65	3.19	2.33	3.03
±SD	0.24	0.19	0.39	0.38	0.33	0.25	0.16	0.18	0.15
range	2.2–3.7	2.3–3.4	2.1–4.4	2.7–4.41	2.7–4.4	2.75–4.17	2.9–3.6	2.2–2.2	2.7–3.3
EyeEar									
mean	2.61	2.49	2.46	2.70	2.65	2.48	2.55	2.47	2.33
±SD	0.23	0.21	0.23	0.28	0.25	0.17	0.14	0.11	0.18
range	2–3	2–3	2–3	2.1–3.4	1.9–3.6	2.2–2.89	2.3–2.8	2.3–2.5	2.1–2.7

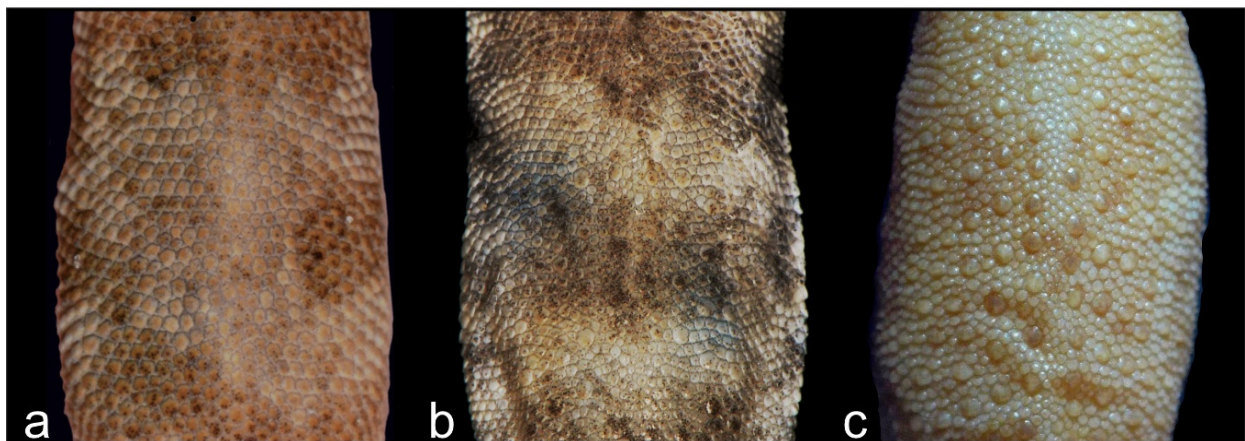


Figure 6. Three different types of dorsal scalation in *Alsophylax*: (a) *Alsophylax ferganensis* sp. nov. with homogeneous dorsal scales; (b) *Alsophylax emilia* sp. nov. with slightly heterogeneous dorsal scales and irregular enlarged tubercles; (c) *A. pipiens* with heterogeneous dorsal scales and regular rows of longitudinal enlarged tubercles.

The main features characterizing and distinguishing it from all of other species are as follows: a maximum SVL of 31.7 mm; 7–8 infralabials; 5–6 supralabials; 1–2 pairs of roundish postmentals, first pair in a broad contact; one nasal scale; 18–22 scales between the

orbits of the eyes; 83–97 longitudinal ventral scales from postmentals to cloaca; 44–51 scales along the midline around the body; 13–15 subdigital lamellae on the fourth finger; 14–18 subdigital lamellae on the fourth toe; males have 6–7 precloacal pores on enlarged scales; precloacal pores on females are absent or 7–8 enlarged perforated scales can be present; 2–3 cloacal spurs on each side; with the subcaudal scales, the central line has slightly enlarged roundish plates (Table 3).

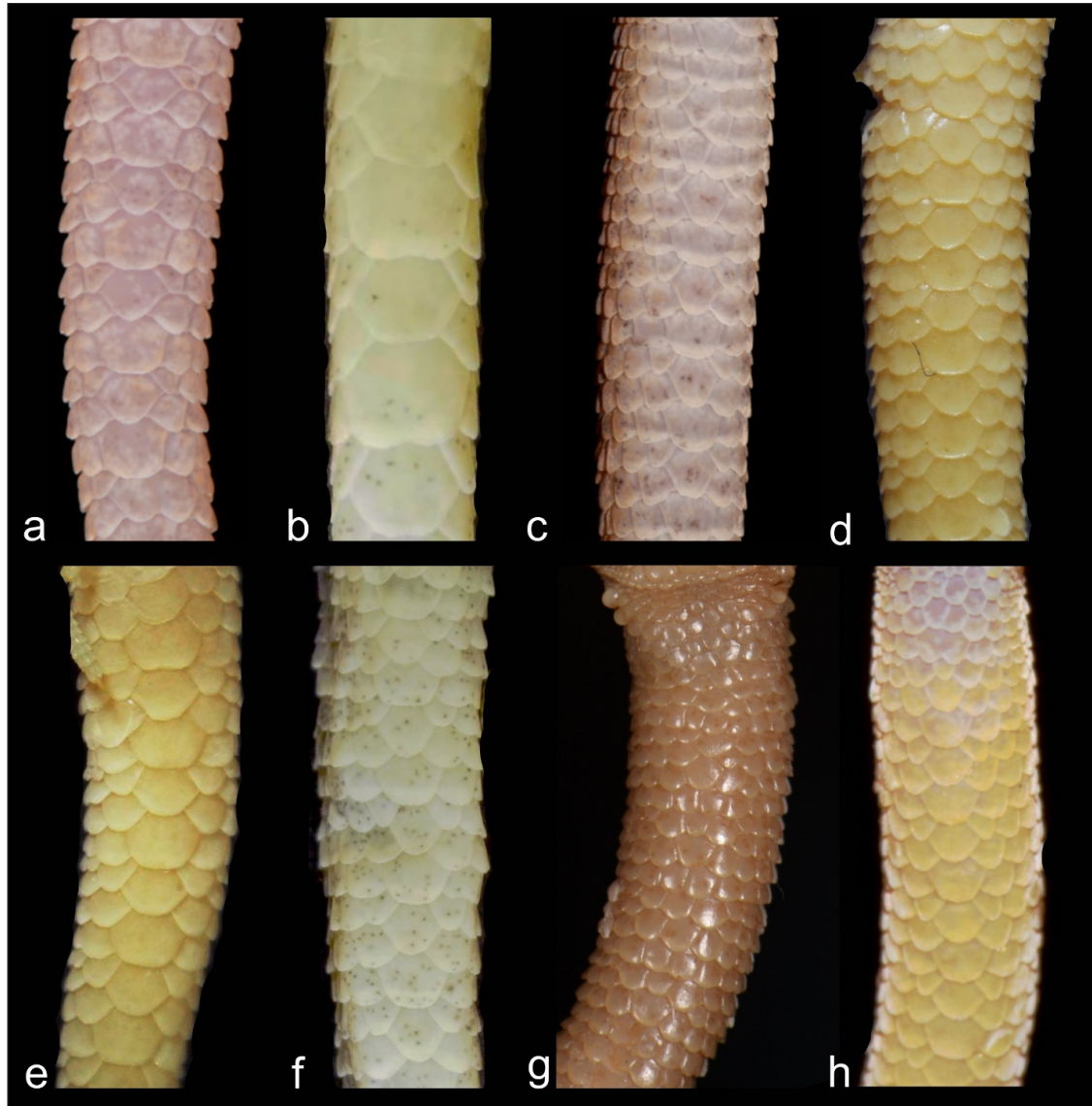


Figure 7. Different type of subcaudal scalation in *Alsophylax* species: (a) *A. ferganensis* sp. nov. with slightly enlarged medial scales; (b) *A. emilia* sp. nov. with medial row of transverse enlarged plates; (c) *A. pipiens* (clade B) from type locality (Mt. Bogdo) with approximately equal subcaudal scales; (d) *A. pipiens* (clade A) from Mongolia ZMMU R-5381, with slightly enlarged medial scales; (e) *A. pipiens* (clade B) from Ustyurt Plateau, western Uzbekistan ZMMU 15426, with noticeably enlarged medial scales; (f) *A. laevis* RAN 4957 from central Uzbekistan, Ayagitma depression; (g) *A. przewalskii* Paralec-totypus ZISP 7016 with small homogeneous subcaudal scales; (h) *A. Tadjikiensis* ZMMU R-16039.

Description of holotype. This is an adult male SVL 29.6 mm with a small teardrop shaped head (HL/SVL 0.27), smoothly passing into the neck. The rostral part is roundish and short (SnEye/HL 0.37), more elongated than the occiput (SnEye/EyeEar 1.11). The ear opening is small and roundish. There is a relatively large eye (Orb D/HL 0.25). The distance between posterior margin of the eye and ear (EyeEar/HL 0.33) exceeds the diameter of the

orbit of the eye. Along the midline of the rostrum, a longitudinal depression is noticeable. The nostril is surrounded by the first supralabial, rostral, and enlarged nasal scale. Seven supralabials and five large infralabials of a rectangular shape are present, which decrease in length in the caudal direction. A large pentagonal mental shield borders on the first labial and two rounded postmentals. There are 18 round-oval scales between the eyes. The upper part of the head is covered by round, small granular scales which are enlarged in the area between the orbits. Large rounded gulars gradually pass into ventral large flat ventral scales (Figure 5b–e).

The body is elongated and slightly flattened, with no lateral folds. The dorsal scales are relatively small compared to the ventral; slightly larger and smaller scales are evenly distributed among them. No enlarged dorsal tubercles. A total of 86 scales are present from postmentals to cloaca, along with 44 around the midbody. Seven elongated, rectangular, perforated precloacal scales form an inverted V-shaped row. The opening of one pore occupies half of the total area of the precloacal scale.

The forelimbs are slender, and the humeral length slightly exceeds the size of the forearm (ForeaL/LS 0.9). The hindlimb is elongated, stronger in structure than the front. The thigh and lower leg are of the same length (CrusL/FemurL 0.1). The forelegs are dorsally covered with smooth juxtaposed scales, while convex granular scales exist on the ventral side of the upper arm, overlapping each other on the forearm. The dorsal surface of the hindlimb is covered by the scales similar to the dorsal ones, in contrast to enlarged scales on the ventral side, smooth and imbricated. The fingers are slender and long. From above, the metacarpus and metatarsus are covered with scales passing from the forearm and lower leg, respectively; those from below the palm and sole are covered with small swollen rounded granules, and the lower surface of the fingers is covered with transverse subdigital lamellae. The fourth digit of the hindlimb is the longest, with 14 slightly swollen subdigital lamellae.

The tail is 36.9 mm longer than the body (SVL/TL 0.8). The base of the tail is slightly swollen; on each side, there are two pairs of postcloacal spurs. The roundish subcaudal plates on the medial line of ventral side of the tail are 1.5–2 times larger than the surrounding scales.

Coloration. The dorsum of the body, head, and limbs are light beige. The pattern on the dorsum is formed by 5–7 transversely dark brown bands with uneven edges; the interspaces between bands is approximately equal to or slightly greater than the width of the bands. There are 7–10 transverse dark stripes on the tail, about the same number as the width of the gaps. Patterns on the head are not pronounced, whereby there is a narrow nuchal loop. The dorsal surface of the limbs is covered with transverse dark bands and irregularly shaped spots. The ventral surface of the body is white.

Distribution. *Alsophylax ferganensis* sp. nov. is only known from the type locality on the border with Kyrgyzstan, on the southern edge of the Fergana Valley (Figure 2). The distribution of *A. ferganensis* sp. nov. is probably limited to this small mountain range, and a preliminary estimation of the available habitat indicates there is less than 50 km². During field observations, another similar population was found on Pap Adyrs, which is located on the opposite side of the Fergana Valley. This isolated population is located 75 km from the type locality of *A. ferganensis* sp. nov., and its taxonomic status remains unclear.

Habitat and natural history. Clay-variegated canyons with sandstone outcrops represent the habitat of *A. ferganensis* sp. nov. (Figure 4b). The vegetation in these habitats consists of various shrubs and other plants. Most of the geckos were found on open hills with puffy cracked soil and at the bottom of the canyon along the sides.

Comparison. All representatives of the genus *Alsophylax* are divided into two groups—one dominant group has enlarged dorsal tubercles (*A. loricatus*, *A. pipiens*, *A. przewalskii*, *A. szczyrbaki*) and the other group does not (*A. laevis*, *A. tadjikiensis*). *Alsophylax ferganensis* sp. nov. belongs to the second group and can be distinguished from *A. loricatus*, *A. pipiens*, *A. przewalskii*, and *A. szczyrbaki* by granular homogeneous dorsal scales without enlarged tubercles (Figure 6). *A. ferganensis* sp. nov. is morphologically closest to *A. laevis*

but differs further by smaller maximal body size, relatively elongate limbs, and a relatively smaller head that is not sharply detached from the body; dorsal patterns are relatively narrower dark transverse bands with approximately equal interspaces in between, in contrast to the well-defined nuchal loop in *A. laevis* with wide transverse dorsal patterns and narrow interspaces. *Alsophylax ferganensis* sp. nov. differs from *A. tadjikiensis* by the following features: 6–8 precloacal pores in new species versus 5–7 pores in *A. tadjikiensis*; transversal dorsal bands versus pattern-less dorsum; bright yellowish or orange coloration of tail in *A. tadjikiensis*.

Etymology. This species is named after the Fergana Valley where it is endemic.

Alsophylax emilia sp. nov. (Figures 3 and 8a)



Figure 8. (a) *Alsophylax emilia* sp. nov. holotype and (b) its habitat.

Holotype. This is an adult male ZMMU Re-17544 (field ID RAN 4917) collected from Uzbekistan, Fergana Valley, Kokand region, in the vicinity of Jildalisoy reservoir, N 40.891349, E 70.884367, by Roman Nazarov, Evgeniya Shepelya, and Mariya Gritsina on 17 June 2022 (Figure 9a).



Figure 9. Holotype of *Alsophylax emilia* sp. nov. (ZMMU Re-17544): (a) general view of preserved specimen; (b) lateral view of the head; (c) gular region showing mental, postmental, and chin scale arrangement; (d) middle of the dorsum with heterogeneous dorsal scales; (e) precloacal region showing scalation pore and spur arrangements; (e) plantar view of feet showing subdigital lamellae.

Paratypes. The adult male UZZI RE-19079 (field ID RAN 4918) collected in the same place as a holotype and ZMMU Re-17545 (field ID RAN 4924) collected from Uzbekistan, Fergana Valley, Namangan region, vicinity of Yartepa village, N 41.067757, E 71.412176, on 18 June 2022 by Roman Nazarov, Evgeniya Shepelya and Bogatova Polina (Table 4).

Table 4. Measurements of the type series of *Alsophylax emilia* sp. nov.

Field No.	Holotype	Paratypes	
	ZMMU Re-17544	UZZI RE-19079	ZMMU Re-17545
	RAN 4917	RAN 4918	RAN 4924
SEX	m	m	m
SVL	35	32.6	31.5
TL	40.2	15.3 regenerated	33.1
HL	9.7	9.2	9
HW	5.8	5.2	5.1
HH	2.7	2.8	2.6
SnEye	3	2.8	3
EyeEar	2.9	2.8	2.6
Orb D	2.1	2.2	2.2
LS	5.8	5.4	5.2
ForeaL	5.1	4.7	4.6
FemurL	6.5	6.4	5.3
CrusL	6.5	6.0	5.7
LD4A	2.5	2.2	2.2
LD4P	3	2.6	2.6
SL (r/l)	8/8	7/7	8/9
IL (r/l)	6/7	6/6	7/6
SEH	22	22	22
LF4	11	12	11
LT4	13	14	14
SLB	97	102	104
PP	8	9	7
Spurs (r/l)	2/2	2/3	2/2
Sq	65	64	59

Diagnosis. *Alsophylax emilia* sp. nov. is a sister to the clade containing lineages of *A. pipiens*, *A. laevis*, and *A. ferganensis* sp. nov. (Figure 1). *Alsophylax emilia* sp. nov. is morphologically closest to the *A. pipiens* (Figure 3; Table 3) and can be distinguished by the following features: enlarged dorsal tubercles flat roundish smooth and larger than surrounding scales by no more than 2.5 times; head shape relatively more massive and sharply delimited from the body; 7–9 precloacal pores in V-shaped line; not elongated limbs; 5–6 wide transversal dorsal bands and narrow interspaces, no contrasting nuchal loop, and wide transverse patterns. The main distinguishing features of the new species are the following: maximum SVL of 35.0 mm; maximum TL 40.2 mm; 8/8 infralabials; 6/7 supralabials; two pairs of small roundish postmentals, which contact mentals; one nasal scale; 22 scales between the orbits; 97–104 longitudinal ventral scales from postmentals to cloaca; 59–65 scales along the midline around the body; 11–12 subdigital lamellae on the fourth finger; 13–14 subdigital lamellae on the fourth toe; 2–3 cloacal spurs on each side;

medial line of subcaudal scales formed by noticeably enlarged plates, 2–3 times larger the surrounding scales (Table 4).

Description of holotype. This is an adult male, SVL 35.0 mm, TL 40.2 mm, with a relatively large head shape (HL/SVL 0.28) that tapers into the neck and body. The rostrum is rounded and relatively elongate (SnEye/HL 0.31). The distance between rostral and occipital parts is approximately the same (SnEye/EyeEar 1.03). The ear opening is small and oval. The eye is relatively small (Orb D/HL 0.22). The distance between the posterior margin of eye and anterior margin of ear (EyeEar 2.9) exceeds the diameter of the orbit (Orb D 2.15).

The nostril is surrounded by the first supralabial, rostral, and one enlarged nasal scale. There are eight supralabials and six large infralabials rectangular in shape, which decrease in size posteriorly. A large mental shield with roundish caudal edge borders with the first labial and four small and rounded postmentals. There are 22 granular scales between the eyes. The upper part of the head is covered by rounded scales which are enlarged on the sides of rostrum and between the orbits. Large, rounded gulars gradually pass into ventral large flat smooth juxtaposed scales (Figure 9).

The body is elongated and slightly flattened, with no lateral folds. The dorsal scales are heterogenic. Among small roundish scales, evenly distributed enlarged dorsal tubercles do not form regular rows (Figure 9d). Enlarged dorsal tubercles are no more than 2.5 times larger than surrounding scales. In the longitudinal medial row from postmentals to cloaca, there are 97 scales, along with 65 scales around the midbody. There are eight precloacal pores, located on elongated rectangular precloacal scales in an inverted V-shaped row (Figure 9). The opening of the pore is large, occupying more than half of the total area of the precloacal scale. Between the row of precloacal pores and cloaca, there are five enlarged scales.

The forelimbs are slender, and the humeral length slightly exceeds the size of the forearm (ForeaL/LS 0.9). The hindlimbs are elongated, stronger in structure than the front. The thigh (6.5 mm) and lower leg are the same length. The dorsal surface of forelimbs and hindlimb is covered with smooth juxtaposed and imbricated scales, similar in size to the dorsal ones. The fingers are slender and not elongate (LD4A/SVL 0.07). From above, the metacarpus and metatarsus are covered with scales passing from the forearm and lower leg, respectively; those from below the palm and sole are covered with small swollen rounded granules, and the lower surface of the fingers is covered with transverse subdigital lamellae. The fourth digit of the hindlimb is the longest, with 13 slightly swollen subdigital lamellae.

The tail is 40.2 mm longer than the body (SVL/TL 0.9), cylindrical, rounded in cross-section, and not segmented. The base of the tail is slightly swollen; on the sides, there are two pairs of postcloacal spurs. The medial row features enlarged subcaudal plates.

Coloration. The background of the dorsum, head, and limbs are light beige (Figure 9d). The dorsal pattern is formed by six wide transversal dark brown bands with uneven edges; the interspaces between bands are approximately equal to or less than the width of the bands. There are 11 transverse dark bands on the tail. Patterns on the head are not pronounced, with a nuchal loop, dark brown strips on the sides of rostrum between eye, and supralabial plates. Moreover, no contrasting dark roundish spot is present on the tip of the rostrum. The dorsal surfaces of the limbs have transverse dark irregularly shaped spots (Figure 9). The color of the venter is white.

Distribution. *Alsophylax emilia* sp. nov. is known from a few localities on the north-western edge of the Fergana Valley (Figure 2). Specimens were found at the three localities on pap foothills (adyrs): vicinity of Jidalisai N40.891349; E70.884367; vicinity of Uygursay (N40.95126; E71.01833); 10 km northwest of Turakurgan village (N41.067757; E71.412176); one locality in the Namangan region, vicinity of Yartepa vill. N 41.067757, E 71.412176. We hypothesize that the distribution of *A. emilia* sp. nov. is probably broader in the Fergana Valley, but future studies are needed to clarify the distribution of this species in the surrounding regions.

Habitat and natural history. The habitat at all known localities of *Alsophylax emilia* sp. nov. was similar and made of clay canyons with outcrops, with sparse vegetation consisting of various shrubs (Figure 8b).

Etymology. This species is named in honor of Soviet and then Uzbek herpetologist Emilia V. Vashetko (24.04.1940–07.11.2022) for her great contributions to the study of the herpetofauna of Uzbekistan and surrounding countries.

Comparison. *Alsophylax emilia* sp. nov. belongs to the group of *Alsophylax* with heterogeneous dorsal scales and enlarged dorsal tubercles, which includes *A. loricatus*, *A. pipiens*, *A. przewalskii*, and *A. szczerbaki* (Table 3). *Alsophylax emilia* sp. nov. is morphologically closest to *A. pipiens*, from which it can be distinguished by the smaller dorsal tubercles on new species, which are no more than 2.5 times smaller than surrounding scales; the medial line of subcaudal scales is formed by noticeably enlarged plates, which are 2–3 times larger than surrounding scales; there are 7–9 precloacal pores versus 8–13 in *A. pipiens* (Figures 8 and 9). *Alsophylax emilia* sp. nov. differs from *A. loricatus*, *A. przewalskii*, and *A. szczerbaki* by having smaller and smooth dorsal tubercles which are sporadically distributed across the back, versus large, strongly keeled trihedral dorsal tubercles organized in regular longitudinal rows; there are smaller scales on the head (22 scales between the eyes versus 8–15 in all three species mentioned above); dorsal patterns consist of transversal dark bands versus unclear dorsal patterns with longitudinal elements (Figure 6).

Alsophylax emilia sp. nov. further differs from *A. tadjikiensis* by the following characteristics: heterogeneous dorsal scalation versus homogeneous dorsal scalation; 7–9 precloacal pores in new species versus 5–7 pores in *A. tadjikiensis*; transversal dorsal bands versus pattern-less dorsum and bright yellowish or orange coloration of tail in *A. tadjikiensis*. *Alsophylax emilia* sp. nov. differs from *A. ferganensis* sp. nov. as follows: a larger body size with a maximum SVL of 35 mm versus 30.3 mm; heterogeneous dorsal scalation versus homogeneous dorsal scalation; elongate fore- and hindlimbs on *A. ferganensis* sp. nov.; transversal enlarged subcaudal plates versus roundish polygonal slightly enlarged subcaudal scales along the midline in *A. ferganensis* sp. nov. (Figure 10).



Figure 10. A comparison of adult male *Alsophylax ferganensis* sp. nov. (top) and *Alsophylax emilia* sp. nov. (bottom).

4. Discussion

4.1. Taxonomy of *Alsophylax* and Conservation in the Fergana Valley

The genetic and morphological data in this study support the hypothesis that these new populations of *Alsophylax* represent undescribed new species, and that they currently appear to be endemic to the Fergana Valley of Uzbekistan (Figures 2 and 10). Given that these new species tentatively belong to separate species groups within *Alsophylax* suggests that the Fergana Valley may have been colonized by at least two different *Alsophylax* lineages (Figure 1). These results further highlight the age and complex geological processes that have helped generate the unique biodiversity in this isolated valley. Additionally, these new species elevate the number of endemic reptiles to the Fergana Valley and Uzbekistan. Lastly, we provided data on population densities for all endemic reptile species found in the Fergana Valley (Table 1; Figures S1–S4) indicating that not all these species respond to habitat degradation in the same manner. We discuss these results in conjunction with the history of previous herpetological studies in the Fergana Valley, and the future of conservation and species discovery in the area.

4.2. The History of Herpetological Study in Central Asia and the Fergana Valley

The history of studies on reptiles inhabiting the territory of Uzbekistan, as was the case with other vertebrates in Central Asia, began with the expedition of E. A. Eversmann and K. Pander from Orenburg to Bukhara (October 1820–April 1821). The few and occasional collections of E. A. Eversmann from these areas were transferred to the University of Berlin, processed by Prof. M. Lichtenstein, and published in 1823 as an appendix to the work of E. A. Eversmann [30].

- H. C. Lichtenstein published a list of 18 species of reptiles (including five new ones) and two species of amphibians [31].
- A. Lehmann in July 1841 crossed the Kuvan-Darya and the Kyzylkum desert, and then visited Samarkand and Bukhara. From there, he traveled to the mountains to Iskenderun and went to Orenburg, Kazakhstan [32].
- Brandt [33] and Nikolsky [34–38] expanded the known number of species in the area including two species of amphibians and 22 species of reptiles.
- A. P. Fedchenko in 1871 worked in the Fergana Valley and visited Kokand, Andijon, Namangan, Vuadil, Uch-Kurgan, and Besh-Aryk. The works by Fedchenko [39–41] included only part of the materials he collected in Central Asia and the Fergana Valley. The remaining collections were mainly used by A. M. Nikolsky and A. A. Strauch in their works.
- Strauch published a list of geckos from Central Asia, compiled their characteristics, and described a number of new species in Central Asia. Of greatest interest are descriptions of the Turkestan thin-toed gecko, Transcaspian bent-toed gecko, and Strauch’s even-fingered gecko from Uzbekistan and other republics of Central Asia [42].
- Nikolsky published “Reptiles and amphibians of the Turkestan general governorship” and gave a complete literary summary at that time [34]. The author processed the materials of A. P. Fedchenko and others who collected in Central Asia. The paper provides information on the distribution of seven species of amphibians, three species of turtles, 42 species of lizards, and 28 species of snakes. Of these, more than half were collected in Uzbekistan [34].
- Bogdanov published his work “Fauna of the Uzbek SSR. Amphibians and reptiles” [30] and provided all the data that he collected during his time doing field work in the Namangan region during 1949, 1950, 1954, and 1955.
- E. V. Vashetko and Z. Kamalova studied racerunners and toad-head agamas living in the central region of the Fergana Valley [43–45].
- T. Yadgarov studied snakes and the conservation of the endemic and unique ecosystems of the Fergana Valley [46,47].

- O.I. Tsaruk paid great attention to the problems and conservation of the unique ecosystems of the Fergana Valley, studying rare and endemic species of *Phrynocephalus* in the Fergana Valley [48].
- Chikin (1998; 2001) assessed the status of populations of a number of species of rare and endemic reptiles in the sands of the Fergana Valley [49,50].
- Bondarenko and Peregontsev (2017) described the spatial distribution of the Central Asian Tortoise, *Testudo horsfieldii* in Uzbekistan, including the Fergana Valley [51].
- Currently, R.A. Nazarov and T.V. Abduraupov pay special attention to the study and conservation of the unique herpetofauna of the Fergana Valley, in particular, carrying out work on Papsky adyrs [4,52,53].

4.3. Conclusions

Lastly, the age of the Fergana Valley allows it to support subtle yet different habitats ranging from claystone outcroppings to massive, isolated sand massifs and xeric flats that each support their own suite of species that are locally adapted to these different micro-habitats. The discovery of possibly two new species (Figures 1 and 3) that are micro-endemic habitat specialists isolated in various clay outcrops and canyons supports the hypothesis that the valley may have been colonized twice at different times. We hypothesize that this possible colonization pattern could indicate that other groups have experienced multiple colonization events and they too have levels of cryptic diversity among their populations. This study highlights the reptile diversity in the Fergana Valley and further supports the need for more surveys focusing on these habitats deemed “non-suitable”, because the data from this study indicate that they may harbor unrecognized biodiversity. If the biodiversity from these areas is not documented and protected, they could become victim to the continued textile and agricultural developments in the Fergana Valley.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/ani13152516/s1>, Figure S1. Distribution of *Eremias scripta pherganensis*. Figure S2. Distribution of *Phrynocephalus strauchi*. Figure S3. Distribution of *Teratoscincus rustamowi*. Figure S4. Top - Distribution of *Alsophylax loricatus*.

Author Contributions: Conceptualization and methodology, R.A.N., T.V.A. and J.L.G.; sample preparation, E.Y.S., M.A.G., R.A.N., D.A.M., J.D.L., M.D.B. and N.A.P.; molecular analysis, N.A.P.; data analysis, E.Y.S. and R.A.N.; manuscript preparation, R.A.N., E.Y.S., J.L.G. and M.D.B. All authors have read and agreed to the published version of the manuscript.

Funding: The initial 2019 expedition was funded by National Geographic Grant NGS 9535-14. This work was financially supported by the project of WWF01434/9E070711/GLO “Conservation of key natural complexes in the Fergana Valley (Republic of Uzbekistan)” of the Michael Succow Foundation, implemented with the support of WWF and CEPF (Critical Ecosystem Partnership Fund) and implementation of the research topic of the Institute of Zoology “Creating a scientific basis for maintaining cadaster of rare and endangered species of animals (on the example of the Fergana Valley)”. This study was supported by the Russian Foundation of Basic Research project RFBR 20-54-56033 and under an international Iran-Russian project INSF 99003440. The molecular study was supported by the Russian Science Foundation (RSF grant No. 22-14-00037) with support of Russian Foundation for Basic Research grant No. 20-54-56033 (specimen collection, specimen examination) and frames of the State Themes of ZMMU 121032300105-0. Lastly, this research was partially funded by the State Themes of ZISP 122031100282-2 (awarded to author D.M.).

Institutional Review Board Statement: Surveys were conducted under the supervision of the State Committee of the Republic of Uzbekistan for Ecology and Environmental Protection.

Data Availability Statement: All data were deposited online.

Acknowledgments: The authors thank Ahmedov Askar, Soldatov Valentin, Adylova Dinara, Khasanov Mirpulat, Mun Yuriy, Bogatova Polina, and Chebotaryov Sergey for their assistance for collecting data in the field. They also thank the State Committee of the Republic of Uzbekistan for Ecology and Environmental Protection for their assistance in preparing permits for the collection of genetic samples.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Appendix A

Table A1. A list of specimens which were used in morphological and phylogenetic analyses.

Species	Collection Number	N	E	H (m)	Locality
<i>A. laevis</i>	ZMMU R-6643	37.4139	65.0347	244	Turkmenistan, Chardzhou region, eastern part of the Obruchev Steppe, vicinity of the Yusun well
	ZMMU R-7280 1–2	40.697583	63.659622		Uzbekistan, Bukhara region, foothills of Kuldzhuk-tau, 10 km west. Shuruk vill.
	ZMMU R-4125	37.271453	60.245347		Turkmenistan, Takhir RW station
	ZMMU R-7281 1–2	40.546495	63.790836		Uzbekistan, Bukhara region, 15 km south Shuruk vill.
	ZMMU R-5895	38.046054	58.035237		Turkmenistan, Gekdere vill.
	ZMMU R-5940	39.213124	55.709714		Turkmenistan, 10 km from Uzun-Su RW station
	ZMMU R-16038	39.508916	54.362538		Turkmenistan, 18 km northwest of Kyzyl Arvat (Sedar city), env. Qishlaq Aji
	ZISP—18936 1–13	37.271453	60.245347		Turkmenistan, station Takyr
	ZISP—19177 1–15	37.371190	60.077820		Turkmenistan, 33 km west of Tejen on the highway to Ashgabat
	ZISP—16612	37.261158	67.307407		Uzbekistan, Kara-su near Termez
	ZISP—18925 1–27	39.015630	56.253282		Turkmenistan, 4 km northwest of Kizyl-Arvat
	IZUAS—1473 1–6	40.682777	64.010022		Uzbekistan, 40 km to the west of Ayagitma (Kyzylkum)
	IZUAS—1474 1–13	40.813600	64.336812		Uzbekistan, 20 km to the northwest of Ayagitma
	IZUAS—1574 1–2	40.682777	64.010022		Uzbekistan, 20 km to the west of Ayagitma
<i>A. loricatus</i>	ZMMU R-10679	40.283611	69.623962		Tajikistan, Leninabad, old fortress.
	ZMMU R-16041	40.289225	70.426283		Tajikistan, Ferghana Valley, env. Kanibadam
	ZMMU R-11424 1–5	40.319699	71.024406		Uzbekistan, Ferghana Valley, env. Kokand city, Sarykurgan village on the Sokh river. Uzbek-Kyrgyz border.
	ZMMU R-16105 1–6	40.535786	70.940439		Uzbekistan, Ferghana Valley, environs of Kokand
	ZMMU R-16106 1–3	40.331407	71.021404		Uzbekistan, Fergana Valley, the bank of the Sokh River. Sarykurgan.
	ZMMU R-16104 1–8	40.535786	70.940439		Uzbekistan, Ferghana Valley, environs of Kokand
<i>A. pipiens</i>	ZMMU R-12915	44.05	69	337	Kazakhstan, western part of the Moinkum Sands
	ZMMU R-5878 1–9	42.757384	107.550913		Mongolia, Galbyn-Gobi (southern), Tavan-Aldyn-Khudun
	ZMMU R-5490 1–2	45.659435	91.154084		Mongolia, Kobdos aimag, 15 km NW of the Ushig outpost
	ZMMU R-6088 1–4	45.467223	106.260296		Mongolia, Middle Gobi aimag, Bayan-Dov
	ZMMU R-12602	44.140570	103.715861		Mongolia, South Gobi aimag, Bayan-zag
	ZMMU R-5881 1–3	-	-		Mongolia
	ZMMU R-13053	45.351402	96.647005		Mongolia, Gobi-Altai aimag, Tsagan-Tolgoin-Bulak, about 30 km on the road from Tsogt to Dzakhoy
	ZMMU R-4253 1–2	43.151441	109.145179		Mongolia, Dornogob, 30 km south of Khuvsgul somon, on the road to Khatan-Bulak
	ZMMU R-4924 1–3	43.229632	101.047568		Mongolia, South Gobi aimag, vicinity of Gurvan-Tes
	ZMMU R-5491 1–3	48.212680	102.217947		Mongolia, Gobi-Altai aimag, Khatsovmiin-bulag, about 50 km S-SE from Khair-Khan
	ZMMU R-5381 1–5	42.333333	103.25	1200	Mongolia, South Gobi aimag, southern slope of the Mt. Baga-Ula
	ZMMU R-5489	43.128934	97.975124		Mongolia, Bayan Khongor aimag, Shara-Khulsny-Bulak
	ZMMU R-4920 1–4	43.251052	100.004418		Mongolia, South Gobi aimag, Naryn-Bulak

Table A1. Cont.

Species	Collection Number	N	E	H (m)	Locality
<i>A. pipiens</i>	ZMMU R-6090	42.533333	106.85		Mongolia, 5 km to the west from Ganz-Mod-Khuduk
	ZMMU R-5492 1–2	45.659435	91.154084		Mongolia, Kobdos aimag, 10 km NW of the Ushig outpost
	ZMMU R-5880 1–2	43.716667	108.633333		Mongolia, Dornogovi aimag, in the ruins of a monastery
	ZMMU R-6089 1–2	44.25	109.283333		Mongolia, Dornogovi aimag
	ZMMU R-5488	46.699222	91.069969		Mongolia, Kobdos aimag, 22 km southwest of the Gurvan Khukhet outpost
	ZMMU R-5254	43.667070	102.933058		Mongolia, 150 km NW from Bayan-Leg (northern slope of the Nem-Get ridge)
	ZMMU R-4921	43.321384	99.329913		Mongolia, vicinity of the Ekhiin-Gol station
	ZMMU R-5385	42.066667	104.416667	1250	Mongolia, South Gobi aimag, 5 km NW from the Jal-Shand-Khuduk well
	ZMMU R-6056	43	107.666667		Mongolia, Aimak Umnegovi
	ZMMU R-7172	49.615853	116.993728		China/Mongolia, South Gobi aimag, eastern tip of Bordzingiin-Gobi, 12 km west of Genghis Khan Wall
	ZMMU R-3908	43.836195	106.549735		Mongolia, South Gobi aimag, 10 km north of the southeastern tip of the Khurkhe-Ula ridge (an extension of the Gobi Altai)
	ZMMU R-5829 25	48.967206	89.963372		Mongolia, the ruins of the monastery Ulgi
	ZMMU R-5382 1–3	41.833333	104.666667	1050	Mongolia, South Gobi aimag, northern tip of the Dzamyn-Khuren-Eds sands, 10 km SE from the Bichit-Usny-Khuduk well
	ZMMU R-4922	43.251052	100.004418		Mongolia, Naryn-Dats-Bulak
	ZMMU R-4925 1–2	43.229632	101.047568		Mongolia, South Gobi aimag, vicinity of Gurvan-Tes
	ZMMU R-4923 317–318	43.909167	9.912222		Mongolia, Haichin-2
	ZMMU R-12914	43.73	79.46		Kazakhstan
	ZMMU R-9571	44.052888	62.711996		Kazakhstan, Kzyl-Orda region, 80 km to the northeast from Chaban-Kazgan, northern Kyzyl-Kum
	ZMMU R-9570 1–6	43.535957	58.688738		Uzbekistan, at the foot of the Chink near Sudachey Lake, in the lower reaches of the Amu-Darya
	ZMMU R-14716	44.94747	68.57365		Kazakhstan, the edge of the floodplain of the Chu River
	ZMMU R-5920	43.423373	78.993863		Kazakhstan, Alma-Ata region, 40 km W-SW Chundzha village
	ZMMU R-336	45.657446	58.602648		Kazakhstan, NW shore of the Aral Sea, Ust-Urt, Kaska-dzhol tract
	ZMMU R-11423 1	43.870681	77.051736		Kazakhstan, surroundings of Kapchagan
	ZMMU R-115 1–3	45.915034	73.613855		Kazakhstan, Cape Korzhun-Tubek, western shore of Lake Balkhash
	ZMMU R-118 1–3	45.474858	73.612777		Kazakhstan, Zhambyl region, Mynaral tract, western shore of the lake. Balkhash
	ZMMU R-9569 1–2	5.252309	63.423455		Kazakhstan, Northern Kyzyl-Kum, 50–70 km SW-W of Dzhusaly station
	ZMMU R-9566	44.481389	64.168056		Kazakhstan, Kum-Kala, Karmakchinsky district, Kzyl-Orda region
	ZMMU R-9565	45.505092	61.612670		Kazakhstan, Erembet-Tunbugut, Karmakchinsky district, Kzyl-Orda region
	ZMMU R-9567	45.597886	63.072142		Kazakhstan, 21 km W from Tunbugut, Karmakchinsky district, Kzyl-Orda region.
	ZMMU R-12917	46.733333	75.366667		Kazakhstan, north of Lake Balkhash, kishlak Ortaderessin
	ZMMU R-13488	44.066667	76.983333		Kazakhstan, Almaty region, about 18 km northwest of Kapchagay, at the foot of the rocks on the banks of the Ili River
	ZMMU R-10682 1–2	50.430058	79.896721		Kazakhstan, 25 km west of Semipalatinsk
	ZMMU R-4293 1–9	50.423652	80.254928		Kazakhstan, Semipalatinsk

Table A1. Cont.

Species	Collection Number	N	E	H (m)	Locality
<i>A. pipiens</i>	ZMMU R-5896	40.45	54.5667		Turkmenistan, Tersakkan tract, about 200 km NE from Krasnovodsk
	ZMMU R-9564 1–2	43.616389	61.926667		Kazakhstan, Western Kyzyl-Kum, Chaban Kazgan well
	ZMMU R-10472	48.144205	46.856669		Russia, Astrakhan region, Big Bogdo mountain
	ZMMU R-9214	48.144205	46.856669		Russia, Astrakhan region, Big Bogdo mountain
	ZMMU R-10849 1–2	48.206567	46.970051		Russia, Astrakhan region, Bogdinsky-Baskungaksky state reserve, steppe between Surikovskaya and Kordonnaya beams
	ZMMU R-4621	48.144205	46.856669		Russia, lower Volga, surroundings of Lake Baskunchak, Mount Bogdo.
	ZMMU R-117 1–3	44.759161	74.432668		Kazakhstan, Tai-Aral island in the south of Lake Balkhash.
	ZMMU R-113 1–5	48.144205	46.856669		Russia, Kyrgyz steppe (Big Bogdo)
	ZMMU R-12568	44.95	63.616667		Kazakhstan
	ZMMU R-12569	45.605099	59.110612		Kazakhstan, Aral Sea, Barsakelmes island
	ZMMU R-6835 1–3	47.616760	80.420510		Kazakhstan, Semipalatinsk region, right bank of the Ayaguz river, 40 km downstream from the city of Ayaguz
	ZMMU R-4903 1–2	48.144205	46.856669		Russia, lower Volga, surroundings of Lake Baskunchak, Mount Bogdo.
	ZMMU R-111				Expedition to the Persian Gulf
	ZMMU R-15912	43.681	108.441		Mongolia, Dornogob aimag, Ungetiin uul
	ZMMU R-15910 1–2	43.608	108.237		Mongolia, Dornogob aimag, southeast of Suykhent
<i>A. przewalskii</i>	ZMMU R-15426 1–8	42.381003	57.370581		Uzbekistan, Ustyurt plateau, northern shore of Sarykamysh lake
	IZASU 120754–120759	42.997157	56.080082		Uzbekistan, Ustyurt
	ZMMU R-16103	-	-		China
	ZISP 8271	37.354466	82.945839		China, Niyadarya
	ZISP 8250	37.110833	79.920833		China, Chotan
	ZISP 8267	35.810567	83.832288		China, Kara-Sai
<i>A. szczerbaki</i>	ZISP 15690 1–3	42.112944	92.112376		China, coast from Bugas to Lukchun
	ZISP 8258 1–3	41.531399	79.496704		China, Chilan-su
	ZMMU R-12087	42.323907	59.180661		Turkmenistan, Tashauz region, Kunya-Urgench
	ZISP 18885 7779–7784	41.650710	59.905444		Turkmenistan, Takhta village on the Amur Darya
	ZISP 18908 1870–1874	41.650710	59.905444		Turkmenistan, Tatauzhskaya region, Takhta village
<i>A. tadjikiensis</i>	ZISP 18519 1–6	42.323393	59.162816		Turkmenistan, the vicinity of the village of Kunya-Urgench
	ZMMU R-16039	-	-		Turkmenistan
	ZISP 18884 1824	37.595005	68.655830		Tajikistan, Kurchantyubinsk region, 7 km from the village of Kyzyl-kakha down the Vakhsh river.
	ZISP 18675	38.219290	69.126832		Tajikistan, Valley of the Vakhsh River, near Kolkhozabad

Appendix B

The Genbank numbers for the 47 samples used in the phylogenetic analyses:

ZMMU_RAN_032_b_A_loricatus_COI_mtDNA	OR298052
ZMMU_RAN_030_b_A_tokobajevi_COI_mtDNA	OR298053
ZMMU_RAN_155_A_tokobajevi_COI_mtDNA	OR298054
ZMMU_RAN_156_A_tokobajevi_COI_mtDNA	OR298055
ZMMU_RAN_157_A_tokobajevi_COI_mtDNA	OR298056
ZMMU_RAN_160_A_tokobajevi_COI_mtDNA	OR298057
ZMMU_RAN_161_A_tokobajevi_COI_mtDNA	OR298058
ZMMU_R_11384_1_A_tokobajevi_COI_mtDNA	OR298059
ZMMU_R_11384_2_A_tokobajevi_COI_mtDNA	OR298060
ZMMU_R_15426_1_A_pipiens_COI_mtDNA	OR298061

ZMMU_R_15426_5_A_papiens_COI_mtDNA	OR298062
ZMMU_RAN_4932_laevis_COI_mtDNA	OR298063
ZMMU_R_A_Fergana_COI_mtDNA	OR298064
ZMMU_RAN_4917_emilia_COI_mtDNA	OR298065
ZMMU_RAN_4918_emilia_COI_mtDNA	OR298066
ZMMU_RAN_4924_emilia_COI_mtDNA	OR298067
ZMMU_R_15426_2_A_papiens_COI_mtDNA	OR298068
ZMMU_R_15426_3_A_papiens_COI_mtDNA	OR298069
ZMMU_R_15426_4_A_papiens_COI_mtDNA	OR298070
ZMMU_RAN_2337a_A_przewalskii_COI_mtDNA	OR298071
ZMMU_R_13488_A_papiens_COI_mtDNA	OR298072
ZMMU_RAN_031_b_A_papiens_COI_mtDNA	OR298073
ZMMU_R_12914_A_papiens_COI_mtDNA	OR298074
ZMMU_R_L_36_A_papiens_COI_mtDNA	OR298075
ZMMU_THD6_A_papiens_COI_mtDNA	OR298076
ZMMU_R_12915_1_A_papiens_COI_mtDNA	OR298077
ZMMU_R_12915_2_A_papiens_COI_mtDNA	OR298078
ZMMU_R_12815_A_papiens_COI_mtDNA	OR298079
ZMMU_RAN_1426_A_papiens_COI_mtDNA	OR298080
ZMMU_R_06_Mediodactylus	OR298081
ZMMU_R_160381_laevis_2_COI_mtDNA	OR298082
ZMMU_R_160382_laevis_2_COI_mtDNA	OR298083
ZMMU_RAN_001_laevis_1_COI_mtDNA	OR298084
ZMMU_RAN_002_laevis_1_COI_mtDNA	OR298085
ZMMU_RAN_003_laevis_1_COI_mtDNA	OR298086
ZMMU_R_160_tokobajevi_COI_mtDNA	OR298087
ZMMU_RAN_004_tadjikiensis_COI_mtDNA	OR298088
ZMMU_R_16039_tadjikiensis_COI_mtDNA	OR298089
ZMMU_R_16040_loricatus_COI_mtDNA	OR298090
ZMMU_R_16041_loricatus_COI_mtDNA	OR298091
ZMMU_R_12816_papiens_COI_mtDNA	OR298092
ZMMU_R_15912_papiens_COI_mtDNA	OR298093
ZMMU_R_15910_1_papiens_COI_mtDNA	OR298094
ZMMU_R_15910_2_papiens_COI_mtDNA	OR298095

References

1. Sindaco, R.; Jeremcenko, V.K. The Reptiles of the Western Palearctic. In *Annotated Checklist and Distributional Atlas of the Turtles, Crocodiles, Amphisbaenians and Lizards of Europe, North Africa, Middle East and Central Asia*; Edizioni Belvedere: Latina, Italy, 2008; Volume 1, p. 580.
2. IUCN. The IUCN Red List of Threatened Species. Version 2022-2. 2022. Available online: <https://www.iucnredlist.org> (accessed on 2 July 2023).
3. Bondarenko, K.A. Transformation of Socio-Cultural Factors Impacting on the external labour migration in Uzbekistan. *Spat. Econ. Pros-Transtvennaya Ekon.* **2020**, *3*, 76–108. [\[CrossRef\]](#)
4. Nazarov, R.A.; Nuridjanov, D.A.; Vashetko, E.V. The current state of endemic reptilian species of the Fergana Valley and possible measures for their conservation. *Contemporary Problems of Conservation of Rare, Disappearing Lowland Animals of Uzbekistan*; Tashkent, Uzbekistan. 2016, pp. 141–149. Available online: <https://istina.msu.ru/publications/article/32600194/> (accessed on 2 July 2023).
5. Nazarov, R.A.; Radjabizadeh, M.; Poyarkov, N.A.; Ananjeva, N.B.; Melnikov, D.A.; Pouyani, E.R. A new species of frog-eyed gecko, genus *Teratoscincus* strauch, 1863 (Squamata: Sauria: Sphaerodactylidae), from central Iran. *Russ. J. Herpetol.* **2017**, *24*, 4. [\[CrossRef\]](#)
6. Bykova, E.A.; Abduraupov, T.V.; Gritsina, M.A.; Esipov, A.V.; Dehkonov, S.I. Current status of rare and endangered species of vertebrates in Fergana region of Uzbekistan. In *Actual Problems of Mathematics and Natural Sciences: Materials of the International Scientific-Practical Conference, Petropavlovsk-Barnaul-Surgut-Novosibirsk*; Surgut State Pedagogical University: Surgut, Russia, 2022; pp. 257–263.
7. Pallas, P. *Zoographia Russo-Asiatica, Sistens Omnium Animalium in Extensio Imperio Rossico et Adjacentibus Maribus Observatorum Recensionem, Domicilia, Mores et Descriptiones, Anatomien Atque Icones Plurimorum*; Caes. Academiae Scientiarum: Petropoli, Russia, 1827; Volume 3, p. 426.
8. Fitzinger, L.J.F.J. *Systema Reptilium*; Fasciculus Primus; Braumüller et Seidel: Wien, Austria, 1843.
9. Szczerbak, N.N.; Golubev, M.L. *The Gecko Fauna of the USSR and Adjacent Regions*; Nauka Dymka: Kiev, Ukraine, 1986; p. 232.
10. Anderson, S.C. The Lizards of Iran. Society for the Study of Amphibians and Reptiles. In *Contributions to Herpetology*; Ithaca: New York, NY, USA, 1999; Volume 15, p. 450.
11. Khan, M.Z.; Mahmood, N. Current population status of diurnal lizards of Karachi, Pakistan. *Russ. J. Herpetol.* **2003**, *10*, 241–244.

12. Bauer, A.M.; Masroor, R.; Titus-Mcquillan, J.; Heinicke, M.P.; Daza, J.D.; Jackman, T.R. A preliminary phylogeny of the Palearctic naked-toed geckos (Reptilia: Squamata: Gekkonidae) with taxonomic implications. *Zootaxa* **2013**, *3599*, 301–324. [[CrossRef](#)] [[PubMed](#)]
13. Agarwal, I.; Bauer, A.M.; Jackman, T.R.; Karanth, P. Cryptic species and Miocene diversification of palaeartic naked-toed geckos (Squamata: Gekkonidae) in the Indian dry zone. *Zool. Scr.* **2014**, *43*, 455–471. [[CrossRef](#)]
14. Gamble, T.; Greenbaum, E.; Jackman, T.R.; Bauer, A.M. Into the light: Diurnality has evolved multiple times in geckos. *Biol. J. Linn. Soc.* **2015**, *115*, 896–910. [[CrossRef](#)]
15. Bondarenko, D.A.; Chelintsev, N.G. A comparative estimation of different methods of the line transect census of desert reptiles. *Bulletin of Moscow Society of Naturalists. Biol. Ser.* **1996**, *101*, 26–35.
16. Bondarenko, D.A. “Raspredelenie i plotnost naseleniya sredneaziatskoy cherepahiv Tsentralnyh Kyzylkumah” [The Distribution and Population Density of the Central Asian Tortoise in Central Kizil-Kum (Uzbekistan)]. *The Bulletin of Moscow Society of Naturalists. Biol. Ser.* **1994**, *99*, 22–27.
17. Bondarenko, D.A.; Peregontsev, E.A.; Mukhtar, G.B. Current state of steppe tortoise (*Agrionemys horsfieldii* Gray, 1844) populations in land-scapes of southern Kazakhstan. *Russ. J. Ecol.* **2008**, *39*, 210. [[CrossRef](#)]
18. Bondarenko, D.A.; Peregontsev, E.A. Reptile communities of the Karakalpakian Ustyurt (Uzbekistan). *Curr. Stud. Herpetol.* **2018**, *18*, 13–26. [[CrossRef](#)]
19. Hillis, D.M.; Moritz, C.; Mable, B.K. *Molecular Systematics*; Sinauer: Sunderland, MA, USA, 1996; Volume 2.
20. Hebert, P.D.; Gregory, T.R. The promise of DNA barcoding for taxonomy. *Syst. Biol.* **2005**, *54*, 852–859. [[CrossRef](#)] [[PubMed](#)]
21. Smith, M.A.; Rodriguez, J.J.; Whitfield, J.B.; Deans, A.R.; Janzen, D.H.; Hallwachs, W.; Hebert, P.D. Extreme diversity of tropical parasitoid wasps exposed by iterative integration of natural history, DNA barcoding, morphology, and collections. *Proc. Natl. Acad. Sci. USA* **2008**, *105*, 12359–12364. [[CrossRef](#)] [[PubMed](#)]
22. Solovyeva, E.N.; Poyarkov, N.A.; Dunaev, E.A.; Duysebayeva, T.N.; Bannikova, A.A. Molecular differentiation and taxonomy of the sunwatcher toad-headed agama species complex *Phrynocephalus superspecies helioscopus* (Pallas 1771) (Reptilia: Agamidae). *Russ. J. Genet.* **2011**, *47*, 842–856. [[CrossRef](#)]
23. Nazarov, R.A.; Poyarkov, N.A.; Orlov, N.L.; Phung, T.M.; Nguyen, T.T.; Hoang, D.M.; Ziegler, T. Two new cryptic species of the *Cyrtodactylus irregularis* complex (Squamata: Gekkonidae) from southern Vietnam. *Zootaxa* **2012**, *3302*, 1–24. [[CrossRef](#)]
24. Nagy, Z.T.; Sonet, G.; Glaw, F.; Vences, M. First large-scale DNA barcoding assessment of reptiles in the biodiversity hotspot of Madagascar, based on newly designed COI primers. *PLoS ONE* **2012**, *7*, e34506. [[CrossRef](#)]
25. Ivanova, N.V.; Zemlak, T.S.; Hanner, R.H.; Hebert, P.D. Universal primer cocktails for fish DNA barcoding. *Mol. Ecol. Notes* **2007**, *7*, 544–548. [[CrossRef](#)]
26. Hall, T.A. BioEdit: A user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucleic Acids Symp. Ser.* **1999**, *41*, 95–98.
27. Posada, D.; Crandall, K.A. MODELTEST: Testing the model of DNA substitution. *Bioinformatics* **1998**, *14*, 817–818. [[CrossRef](#)]
28. Stamatakis, A. RAxML version 8: A tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics* **2014**, *30*, 1312–1313. [[CrossRef](#)]
29. Chan, K.O.; Grismer, L.L. A standardized and statistically defensible framework for quantitative morphological analyses in taxonomic studies. *Zootaxa* **2021**, *5023*, 293–300. [[CrossRef](#)]
30. Bogdanov, O.P. *Fauna Uzbekskoj SSR. T. 1. Zemnovodnye i Presmykajuschiesya 1. [The Fauna of the Uzbek SSR. T. 1. Amphibians and Rep-Tiles]*; Izdatelstvo Akademii Nauk Uzbekskoy SSR [Uzbek SSR Academy Sciences Publishing House]: Tashkent, Uzbekistan, 1960; p. 260.
31. Lichtenstein, M.H.C. Verzeichniss der Doubletten des zoologischen Museums der Königl. In *Universität zu Berlin nebst Beschreibung vieler bisher unbekannter Arten von Säugethieren, Vögeln, Amphibien und Fischen*; Königl. Preuss. Akad. Wiss. T. Trautwein: Berlin, Germany, 1823; p. 118.
32. Lehmann, A. *Alexander Lehmann's Reise nach Buchara und Samarkand in den Jahren 1841 und 1842 (Nach den hinterlas-senen Schriften desselben bearbeitet, und mit Anmerkungen versehen von G. v. Helmersen); Nebst einem zoologischen An-haenge von J.F.Brandt.*; Kaiserlichen Akademie der Wissenschaften: Wien, Austria, 1852.
33. Brandt, J.F. Zoologischer Anhang. In *Alexander Lehmann's Reise Nach Buchara und Samarkand in den Jahren 1841 und 1842*; Beitr. z. Kenntn. d. Russ. Reiches; Kaiserlichen Akademie der Wissenschaften: Wien, Austria, 1852; p. 299.
34. Nikolsky, A.M. Reptiles and amphibians of the Turkestan general-governorship (Herpetologia Turanica). AP Fedchenko, Travel to the Turkestan of the member-founder of the AP Fedchenko Society, accomplished on behalf of the Imperial Society of Amateurs of natural history, anthropology, and ethnography. *Zoogeographical Investig.* **1899**, *23*, 21–84.
35. Nikolsky, A.M. Reptiles and amphibians of Russian Empire (Herpetologica Russica). *Mem. De L'academie Imp. Des Sci. De St.-Petersbour* **1905**, *17*, 518.
36. Nikolsky, A.M. *The Fauna of Russia and Adjacent Countries. Reptiles (Reptilia), Vol. 1. Chelonia and Sauria*; Academia of Science: Petrograd, Russia, 1915; p. 534.
37. Nikolsky, A.M. *Fauna of Russia and Adjacent Countries. Reptiles (Reptilia) Vol. 2. Ophidia*; Academia of Science: Petrograd, Russia, 1916; p. 247.
38. Nikolsky, A.M. *Fauna of Russia and Adjacent Countries. Amphibia*; Academia of Science: Petrograd, Russia, 1918; p. 344.
39. Fedchenko, A.P. Puteshestvie v Turkestan [Travels in Turkestan]. *Turkestan Vedemosti* **1870**, *15*, 91–92.

40. Fedchenko, A.P. Report of the Turkestan scientific expedition of the society (from 1869 to April 15, 1870). *Izv. Imp. Obs. Lubit. Estestvozn. Antropol. I Etnogr.* **1871**, *8*, 135–190.
41. Fedchenko, A.P. Voyage to Turkistan. CH. II. In *Kokan Khanate*; Izvestia Imperatorskogo O-va Lyubitelei Estestvoznania, Antropologii, i Etnografii: Moscow, Russia, 1875; Volume 7, p. 176.
42. Strauch, A.A. Bemerkungen über die Geckoniden-Sammlung im zoologischen Museum der Kaiserlichen Akademie der Wissenschaften zu St. Petersburg. *Mémoires De L'académie Impériale Des Sci. De St. Pétersbourg Ser.* **1887**, *7*, 1–72.
43. Vashetko, E.V. Ecology of rapid racerunner in Fergana Valley. *Zool. Zhurnal* **1972**, *51*, 153–155.
44. Vashetko, E.V.; Kamalova, Z.Y. Turtles, Lizards. In *Pozvonochnye Zhivotnye Ferganskoi Doliny [Vertebrate Animals of the Fergana Valley]*; FAN Publ.: Tashkent, Uzbekistan, 1974; pp. 60–74.
45. Vashetko, E.V.; Kamalova, Z.Y. On the Problem Creating a Reserve for the Conservation Endemic Reptile Species in the Fergana Valley. In *Okhrana Zhivotnogo Mira i Rastenii Uzbekistana: Tezisy Konferentsii [Conservation of the Flora and Fauna of Uzbekistan]*; Fan Publ.: Tashkent, Uzbekistan, 1978; pp. 16–17.
46. Yadgarov, T. Snakes. In *Vertebrate Animals of Fergana Valley*; FAN: Tashkent, Uzbekistan, 1974; pp. 75–84.
47. Yadgarov, T.; Allabergenov, K. On conservation of gene pools of the vertebrate animals fauna of the Yazyavan Desert. *Uzb. Biol. J.* **1990**, *2*, 59–61.
48. Tsaruk, O.I. Toad-heads agamas (*Phrynocephalus*) of Uzbekistan. The state of populations and prospects for conservation. In *Reserves of Uzbekistan*; Chinor ENK: Tashkent, Uzbekistan, 2001; Issue 3; pp. 72–77.
49. Chikin, Y.A. *Sokhranenie Bioraznobraziya Central'noy Azii, [Conservation of the Biodiversity in the Central Asia]*; Zoohobbi: Alma-Ata, Kazakhstan, 1998; Volume 3.
50. Chikin, Y.A. Protected reptile species from sands of Fergana. In Proceedings of the 1st meeting of the Nikolsky Herpetological Society, Puschino, Russia, 4–7 December 2000; pp. 327–328.
51. Bondarenko, D.A.; Peregontsev, E.A. Distribution of the Central Asian Tortoise *Agrionemys horsfieldii* (Gray, 1844) in Uzbekistan (range, re-gional and landscape distribution, populations density). *Curr. Stud. Herpetol.* **2017**, *17*, 3–4, 124–146.
52. Nazarov, R.A.; Abduraupov, T.V. New data on distribution and conservation of endemic reptile species in the Fergana Valley. In Proceedings of the Problems of Herpetology: Program and Abstracts of the VIII Congress of the A. M. Nikolsky Herpetological Society (NHS) of the Russian Academy of Sciences «Current Herpetological Research in Eurasia», Moscow, Russia, 3–9 October 2021; pp. 188–189.
53. Abdulakimovna, M.M.; Narkuziyevich, A.O. Review of literature on Helminthofauna of Rodenta in the territory of the Republic of Uzbekistan. *Gospod. I Innov.* **2022**, *21*, 245–249.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.