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Review Article

Systematics and distribution of the genus *Phrynocephalus* Kaup, 1825 (Sauria: Agamidae) in the Iranian Plateau: A Review

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Abstract

There are numerous published data related to the taxonomic structure and distribution of one of the most diverse and taxonomically confusing Iranian lizards, the genus *Phrynocephalus*. The genus *Phrynocephalus* has a close relationship with genera *Stellagama*, *Paralaudakia*, and *Laudakia*. There are about 10-12 species of this monophyletic genus in desert regions of Iran. This study aims to provide a review and a brief comparison of taxonomic changes as well as the distribution of the Iranian Plateau *Phrynocephalus* species.

Keywords: Agamidae, Iranian Plateau, *Phrynocephalus*, Reptilia, Squamata

Introduction

The toad-headed agamid lizards of the genus *Phrynocephalus* Kaup, 1825 with the first species described as *Lacerta helioscopa* by Pallas in 1771, is the most speciose genus in the family Agamidae in the Iranian Plateau and Central Asia. This genus encompasses from 28 to over 42 species, distributed from China to the western side of the Caspian Sea and Southward to the Arabian Peninsula (Moody, 1981; Barabanov and Ananjeva, 2007; Guo and Wang, 2007; Uetz et al., 2010; Gong et al., 2014). The genus *Phrynocephalus* is one of the most important components of the Central Asian desert fauna and is highly adapted to desert environments from sea level up to 6,400 m (Zhao & Zhou, 1999). *Phrynocephalus* species mostly inhabit and are well adapted to two kinds of substrates, hard (comprised of gravel, clay, and dry lakebed) or soft (large and small sand dunes), which is an ancestral characteristic for *Phrynocephalus* (Zhao and Zhou, 1999; Ananjeva NB, 2006; Macey et al., 2018). According to Macey et al.

(2018), the subfamily Agaminae (including *Phrynocephalus*) has been originated in the Gondwanan block of Afro-Arabia. When Arabia began to collide with Eurasia (18 MYA), a route was provided for *Phrynocephalus* to migrate north into Eurasia (Macey et al., 2000; Macey et al., 2018). Because of widespread distribution, variation in morphology, and chromosomal structure, systematics of the genus *Phrynocephalus* is very complicated with many controversial points of view about phylogeny. The family Agamidae in Iran includes 3 subfamilies (Agaminae, Draconinae, Uromastycinae), 7 genera, and 22 species (Safaei-Mahroo et al., 2015; Bauer, 2019). The genera *Laudakia*, *Paralaudakia*, *Phrynocephalus*, and *Trapelus were* placed in the subfamily Agaminae. Numerous phylogenetic studies confirm the monophyly of Agaminae and it splits into two clades (Solovyeva et al., 2014). The first clade of Agaminae consists of Afro-Arabian genera *Agama, Xenagama, Pseudotrapelus, Trapelus* and *Bufoniceps*. Based on outer morphology, it was believed that the genus *Bufoniceps* is a part of *Phrynocephalus* but several studies placed *Bufoniceps* in a close position to *Trapelus* (Macey et al., 2006; Melville et al., 2009; Solovyeva et al., 2014). The second clade combines the genus *Phrynocephalus* and the members of mountain Agamas (*Laudakia* sensu lato) (Solovyeva et al., 2014). Overall, the genus *Phrynocephalus* is a monophyletic group, and its position as the sister taxon to a clade consisting of genera *Stellagama*, *Paralaudakia,* and *Laudakia* are established (Solovyeva et al., 2018b). According to literature to date, about 42 species of *Phrynocephalus* have been described and about 10-12 of these species occur in Iran (Moody, 1981; Pang et al., 2003; Barabanov and Ananjeva, 2007; Guo and Wang, 2007; Uetz et al., 2010; Kamali and Anderson., 2015). This study aims to briefly review the taxonomic status as well as distribution of the Iranian Plateau species of *Phrynocephalus.*

Taxonomic and distributional account

Order Squamata Oppel, 1811

Family Agamidae Gray, 1827

Subfamily Agaminae Gray, 1827

Genus *Phrynocephalus* Kaup, 1825

Species *Ph. maculatus* Anderson, 1872; *Ph. ahvazicus* Melnikov, Melnikova, Nazarov, Rajabizadeh, Al-Johany, Amr & Ananjeva, 2014; *Ph. scutellatus* (Olivier, 1807); *Ph.ananjevae* Melnikov, Melnikova, Nazarov & Rajabizadeh, 2013; *Ph. horvathi* Méhely, 1894, *Ph. persicus* De Filippi, 1863; *Ph. helioscopus* (Pallas, 1771); *Ph. mystaceus* (Pallas, 1776); *Ph. vindumi* Golubev, 1998; *Ph. lutensis* Kamali and Anderson, 2015.

***Phrynocephalus maculatus* Anderson, 1872**

***Ph. m. maculatus* Anderson, 1872**

Common Name: Spotted Toad-headed Agama, Agama-ye sar-vazaqi-ye.

Type Locality: Abadeh (north of Shiraz), Fars province, Iran(Anderson, 1999)**.**

Distribution: *Phrynocephalus maculatus* Anderson, 1872 is widely distributed from southwest Pakistan, southern Afghanistan, through Iran to Eastern Arabia and South East Jordan (Sindaco et al., 2008). As Macey et al. (2018) reported, it is restricted to salt-bed dry lakes on the Iranian Plateau and adjacent Baluchistan Plateau including the base of the Sulaiman Range of southern Pakistan (Macey et al., 2018).

Diagnosis: No cutaneous fold at an angle of mouth; no fringe of scales on the posterior border of thigh and sides of the base of tail; sides of head and neck without projecting fringe-like scales; dorsal scales homogeneous; no enlarged scales along flanks; scales on vertebral region considerably larger than those on flanks; nasals separated by one to three scales; tail 140 – 158 percent of the snout-vent length (Anderson, 1999).

Remarks: Macey et al. (2018) described a study on phylogenetic relationships of the genus *Phrynocephalus,* based on complete regional sampling, recognized all previous subspecies of *Ph. maculatus* (*Ph. golubewii, Ph. longicaudatus, and Ph.maculatus*) as distinct species on the minim-basis of non-monophyly (Macey et al., 2018). According to Melnikov et al. (2015), *Ph. maculatus* is related, yet outside and sister to a clade containing *Ph. arabicus* and *Ph. longicaudatu*. *Phrynocephalus arabicus (*sensu lato) groups differ from out_groups of *Ph. maculatus* by 9.4 – 9.6% and of *Ph. longicaudatus* by 6.7 – 8.5% in the uncorrected pairwise distance (Melnikov et al., 2015). Uplifting of the Zagros Mountains from 5–10 MYA, served as a barrier and separated *Ph. arabicus* and *Ph. longicaudatus* from *Ph. maculatus* (François et al., 2014).There is no corridor crossing the Zagros Mountains for this genus and no ecologically continuous areas between the present ranges of *Ph. maculatus* and *Ph. longicaudatus* (currently known from Jordan, Kuwait, Saudi Arabia, Oman, Iraq, and the United Arabian Emirates) (Sindaco et al., 2008; François et al., 2014; Macey et al., 2018).

***Phrynocephalus scutellatus* (Olivier, 1807)**

Common Name: Gray Toad-headed Agama, Agama-ye sar-vazaqi-ye khakestari.

Type Locality: mt. Sophia, near Esfahan Province, Iran.

Distribution: The whole of Central Plateau is bounded by the Zagros mountains in the west and by the Alborz and Kopet dagh in the north, and south through Baluchistan to the range of the Makran. It extends eastward along the border regions of southern Afghanistan and northern Baluchistan, Pakistan (Anderson, 1999).

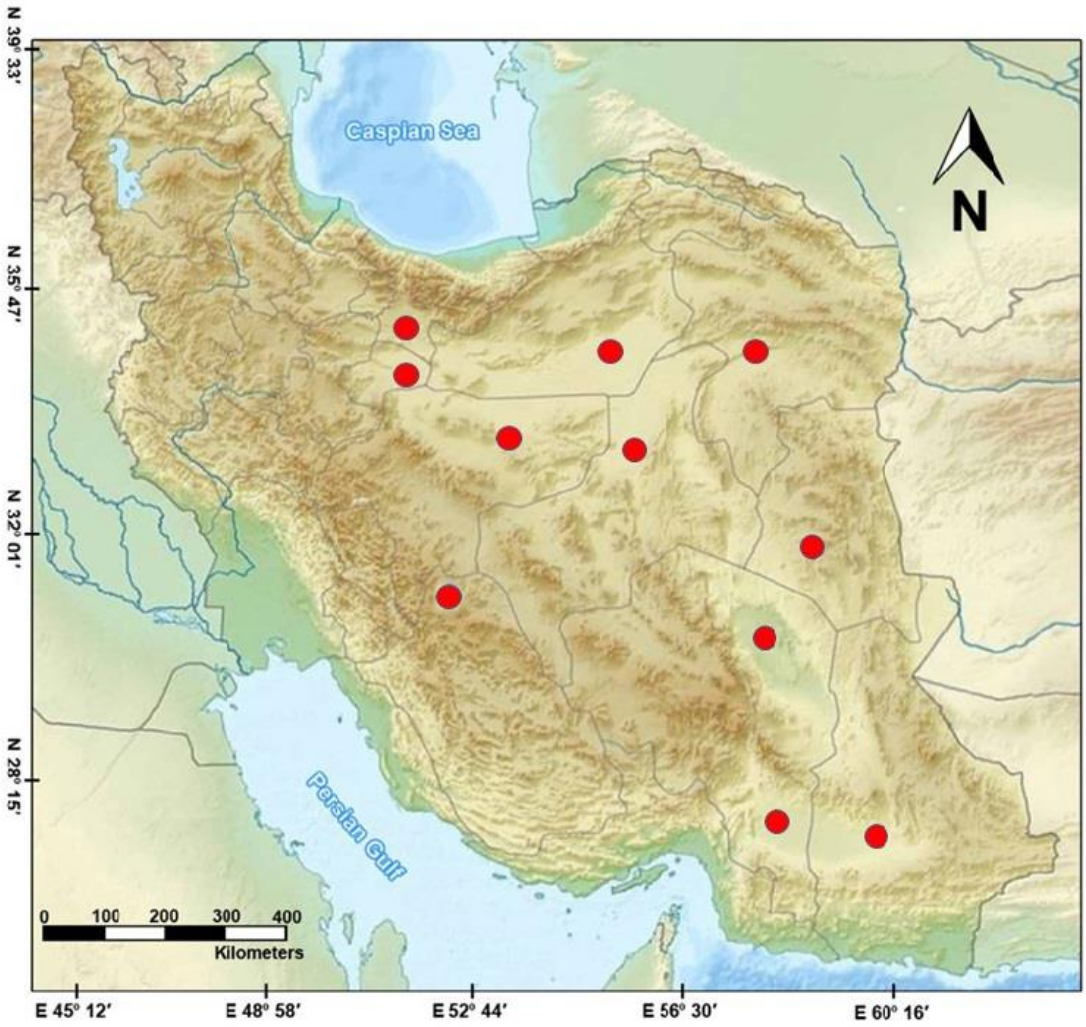

Figure 1. Distribution of *Phrynocephalus maculatus* in Iran.

Diagnosis: Dorsal scales heterogeneous; enlarged scales nail-like, with free posterior margin often tubercular, more than 16 scales across head between eyes; width of space between nostrils equal to or less than half distance between nostril and preocular ridge; sides of the back of head and neck without long, flat, upturned fringe-like scales (but sometimes with short, spiny scales); nasals large, in contact, or rarely separated by single series of scales; crossbars on tail most intense (black) and always present ventrally, though usually quite dark dorsally as well. Tail 118-157 percent of snout-vent length (Anderson, 1999).

Remarks: Based on molecular data four major lineages of the Iranian *Ph. scutellatus* species complex are divided into the southern and northern groups (Rahimian et al., 2015). Rahimian et al. (2015) suggested that the common ancestor of this species complex occurred in the central areas of the Iranian plateau. Macey et al. (2018) placed *Ph. scutellatus* in a clade including Arabian species-group (*Ph. arabicus, Ph. longicaudatus, Ph. maculatus*) (Macey et al., 2018). Solovyeva et al. (2018) placed *Ph. scutellatus* of the Iranian Plateau in Subgenus *Phrynosaurus* Fitzinger, 1843 and based on nuDNA topology united it within a clade along with

Microphrynocephalus, Arabian species-group, and *Megalochilus* (Solovyeva et al., 2018b). Their study showed that the nuclear phylogeny and mtDNA genealogy did not depict a shared heritage for *Ph. scutellatus* and the Arabian species group, but rather *Ph. scutellatus* was the sister lineage of *Microphrynocephalus*. Nevertheless, the phylogenetic position of *Ph. scutellatus* within the clade remains unclear (Solovyeva et al., 2018b).

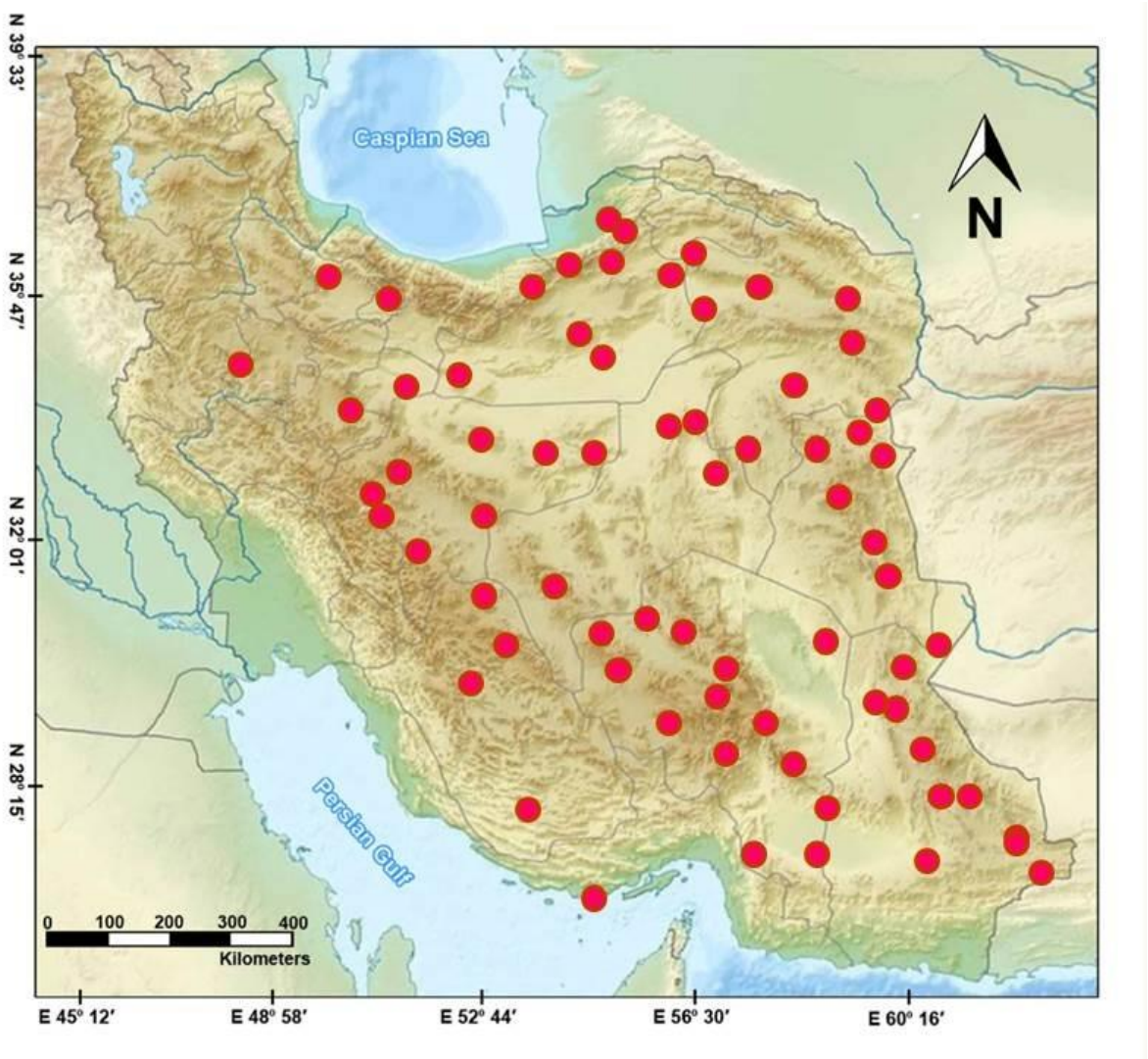

Figure 2. Distribution of *Phrynocephalus scutellatus* in Iran

***Phrynocephalus ahvazicus* Melnikov, Melnikova, Nazarov, Rajabizadeh, Al-Johany, Amr & Ananjeva, 2014**

Common name: Ahvaz Toad-Headed Agama, Agama-ye sar-vazaqi-ye Ahvaz

Type Locality: Ahvaz, Khuzestan Province.

Distribution: Known only from the type locality in Ahvaz, Khuzestan Province.

Diagnosis: *Ph. ahvazicus* is distinguished from the other representatives of the *Ph. arabicus* complex by the following characteristics: smallest body size; longest tail both in males and in females; uniform coloration of dorsal parts without patches on head and dorsum; coloration

of the lower tail regions white in calm condition, and distal half black and proximal half is white without a pattern in alerted animals (Melnikov et al., 2014).

Remarks: Melnikov et al. (2014) described a new *Phrynocephalus* species from south-western Iran, the Ahvaz plains as *Phrynocephalus ahvazicus* (Melnikov et al., 2014). Based on genetic and morphological characters, *Ph. ahvazicus* differs from all other representatives of the species of *Ph. arabicus* Anderson 1894 complex by body and tail proportions, dorsal coloration, lower tail coloration, and genetic characters. Because Melnikov et al. (2014) did not include many morphological characters in the description of the new species and small to moderate genetic distances between *Ph. arabicus* and *Ph. ahvazicus* (p-distance 2.7–6.0%) these data must be taken with caution (Kamali and Anderson, 2015; Solovyeva et al., 2018b).

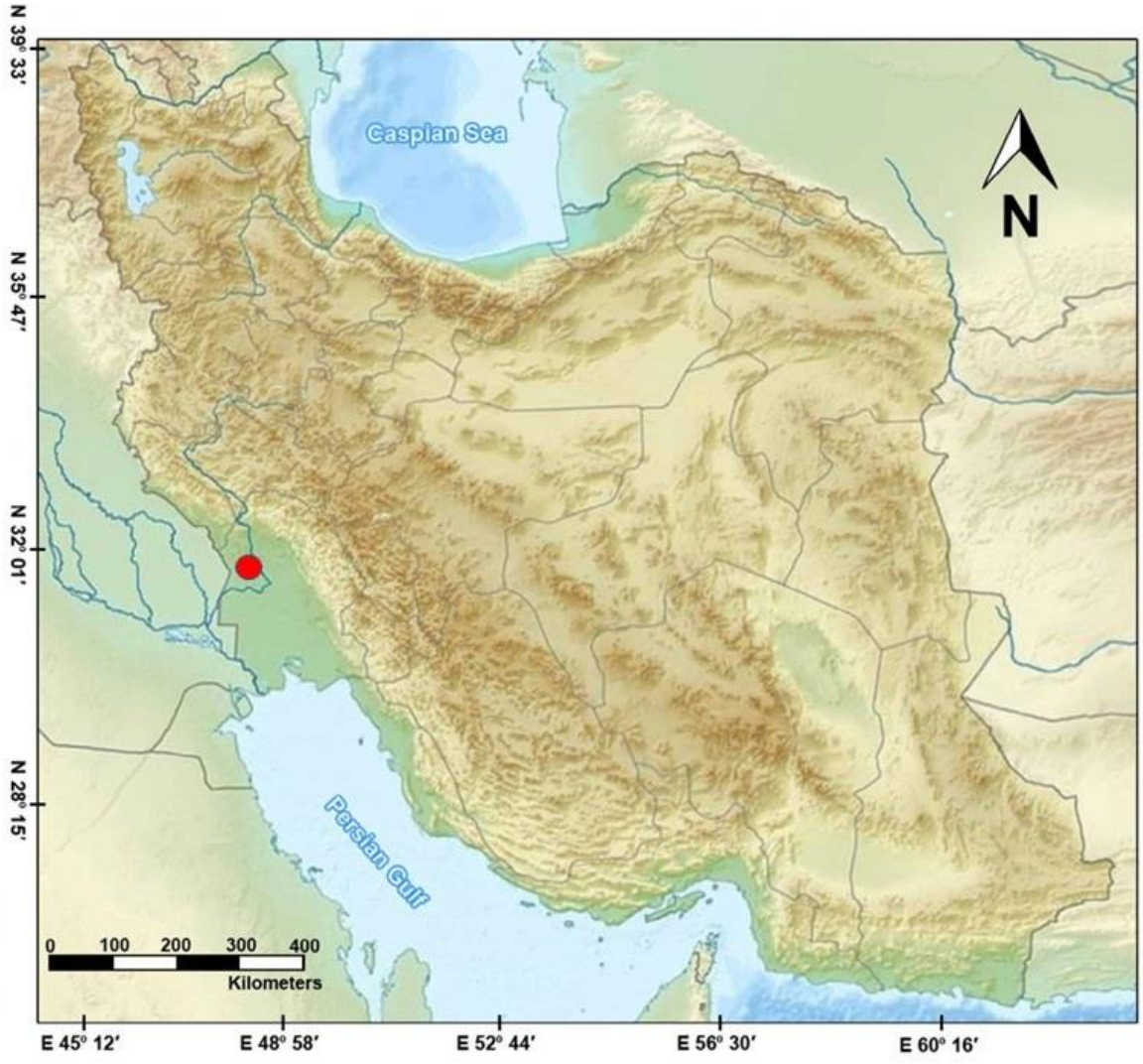

Figure 3. Distribution of *Phrynocephalus ahvazicus* in Iran

***Phrynocephalus ananjevae* Melnikov, Melnikova, Nazarov & Rajabizadeh, 2013**

Common Name: Zagros Toad-headed Agama.

Type Locality: Qahferokh, vicinity of Farokhshahr (approximately 32°16'N, 50°58'E), Chahar Mahal, and Bakhtiari Province.

Distribution: Species are known from southern Iran, the Zagros Mountains in the vicinity of Kahferokh and Abadeh.

Diagnosis: A medium-sized *Phrynocephalus* with enlarged thorny scales on the dorsal side of the body, forming distinguishable crest on the neck; with a short tail, that shorter or equal to the body, in males slightly longer; without jet-black tail-tip; with longitudinal row of enlarged scales along the vertebra; with a big distance between nostrils (up to 5 scales in one row); nostrils directed forward, supra- and infra nasals same size as surrounding scales (Melnikov et al., 2013).

Remarks: *Phrynocephalus ananjevae* Melnikov, Melnikova, Nazarov et Rajabizadeh, 2013 was described from the Zagros mountains (Melnikov et al., 2013). It differs from sun-watcher agamas of *Ph. helioscopus*, *Ph. Horváthi*, and *Ph. persicus* in presence of enlarged thorny scales on the dorsal side of the body that form a distinguishable crest on the neck and absence of distinguishable jet-black tail tip, which presented in *Ph. helioscopus*. The tail in *Ph. ananjevaeis* shorter than *Ph. helioscopus* (Melnikov et al., 2013).

***Phrynocephalus helioscopus* (PALLAS, 1771)**

***Ph. h. helioscopus* (PALLAS, 1771)**

Common Name: Sunwatcher Toad-headed Agama, Agama-ye sar-vazaqiye khorshid-parast

Type Locality: Inderskja Gory, Lower Ural River Region

Distribution: Golestan, Semnan, Khorasan Razavi and Sistan va Baluchestan Provinces.

Diagnosis: Nasals separated by 3-5 series of scales; width of space between nostrils more than one-half, but not equal to the distance between nostril and preocular ridge; scales of back heterogeneous, enlarged scales nail-like, often tubercular, a large part of scale raised free of back; sides of head and neck without long flat upturned fringe-like scales (but sometimes with short spiny scales); one or both sides of the fourth toe with short fringe; crossbars on tail usually most intense dorsally; nostril not visible in entirety when head viewed from the side; no nuchal crest of mucronate, tubercular scales; transverse fold of skin across the back of the neck (Anderson, 1999).

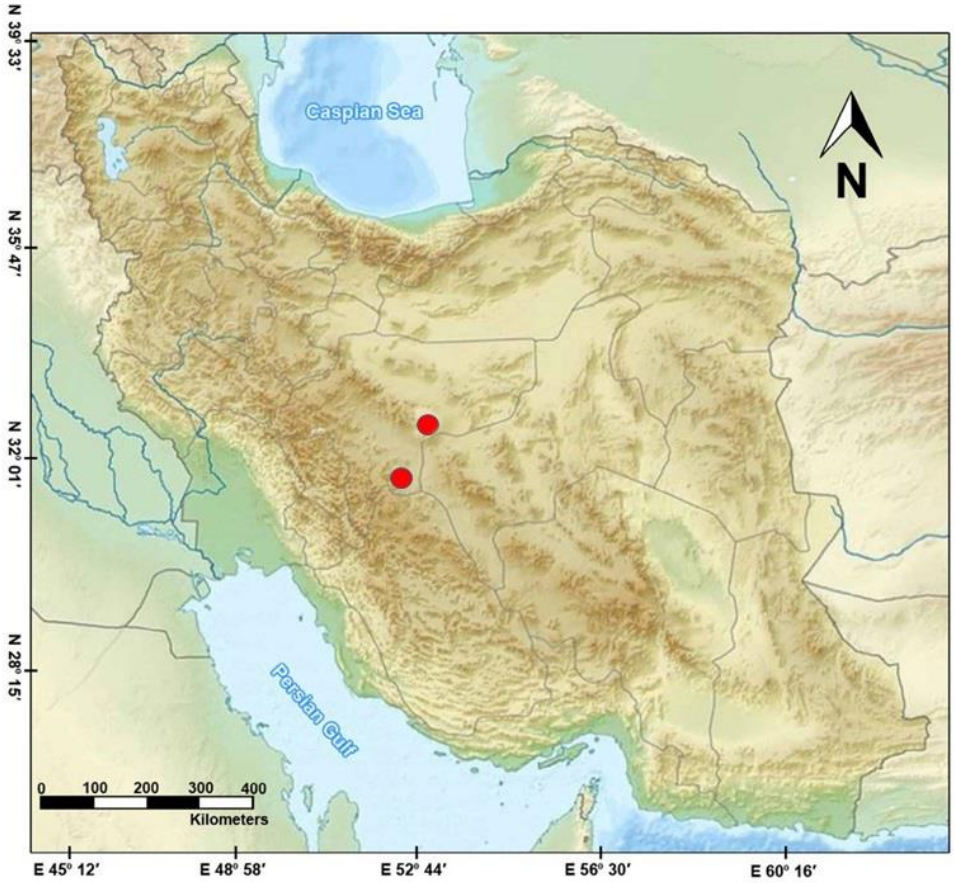

Figure 4. Distribution of *Phrynocephalus ananjevae* in Iran

Remarks: Several diagnostic characters were proposed to distinguish *Ph. helioscopus* from *Ph. persicus* (Filippo de Filippi, 1863, 1865; Anderson, 1872; Blanford, 1876; Boetteger, 1886; Nikolsky (1905, 1907 *a*, *b*, 1909); Bedriaga, 1907) and *Ph. h. horvathi* (Méhely, 1894 *a*, *b*, 1899; Nikolsky, 1913, 1915). Based on Melnikov et al. (2013), *Ph. helioscopus* distinguished from two other sun-watcher toad-headed agamas by jet-black tail tip (Melnikov et al., 2013). Solovyeva et al. (2011) indicated the presence of two main clades within this complex: *Ph. helioscopus* complex (Middle Asia and adjacent territories) and *Ph. persicus* complex (Iran and Transcaucasia), both of which contained several highly divergent lineages (Solovyeva et al., 2011).

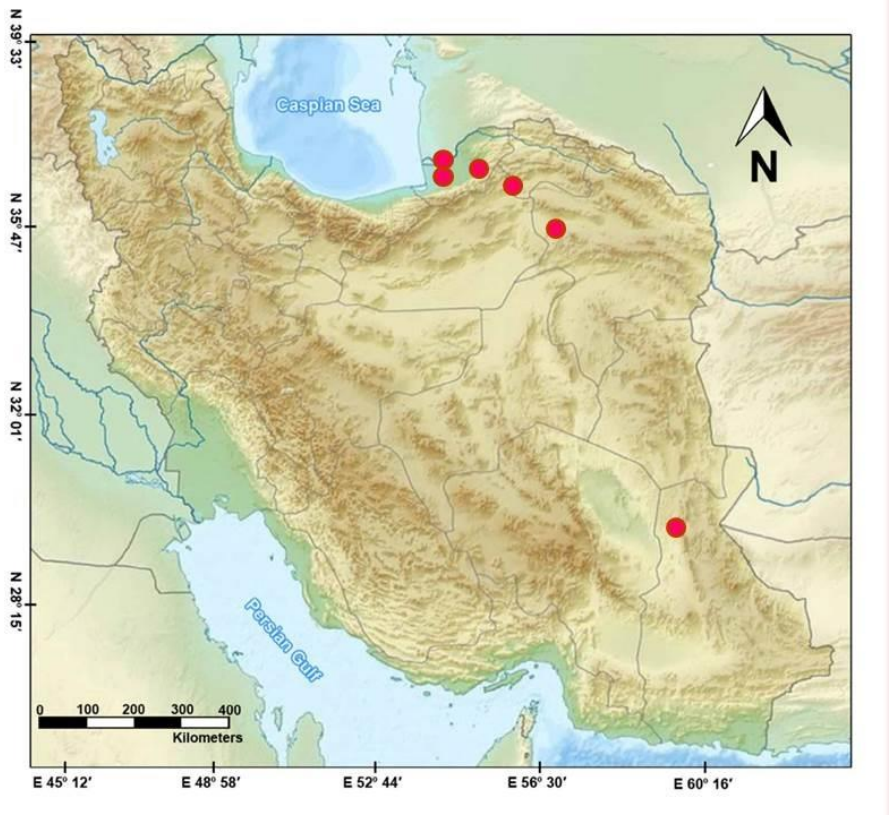

Fig 5. Distribution of *Phrynocephalus helioscopus* in Iran

***Phrynocephalus persicus* DE FILIPPI, 1863**

Common Name: Persian Toad-headed Agama, Agama-ye sar-vazaqi-ye Parsi (P)

Type Locality: Filippo de Filippi 1863 designated type territory of *Ph. persicus* as road from Armenia to Tehran but later, in 1865, he restricted type territory of *Ph. persicus* to the flat deserts of Iran by the road from Sultaniyeh to Tehran (Anderson, 1999; Ananjeva, 2006; Barabanov and Ananjeva, 2007)**.**

Distribution: Zanjan, Ardabil, East Azarbaijan, Kordestan, Qazvin, Tehran, Alborz, Qom, Markazi, Chahar Mahal Va Bakhtiari, and Esfahan Provinces

Diagnosis: Nasals separated by 3-5 series of scales; width of space heterogeneous equal to the distance between nostril and preocular ridge; scales of back heterogeneous, enlarged scales nail-like, often tubercular, a large part of scale raised free of back; sides of head and neck without long flat upturned fringe-like scales (but sometimes with short spiny scales); one or both sides of the fourth toe with short fringe; crossbars on tail usually most intense dorsally; entire nostril visible when viewed from the side; the longitudinal nuchal crest of 3-8 mucronate, tubercular scales; no distinct transverse fold of skin across the back of the neck (Anderson, 1999).

Remarks: In some studies, *Phrynocephalus persicus* De Filippi, 1863 and *Phynocephalus helioscopus* (Pallas, 1771) are considered as synonyms and in the others are known as different species. Some diagnostic characteristics that separated *Ph. persicus* from *Ph. helioscopus* are enlarged thorny scales that protrudes in groups on the dorsal side of the body and form one long row in the middle of the neck, scales on the thighs not keeled, nostrils separated by each other by five scales in one row, the snout is more blunt (Melnikov et al., 2013).

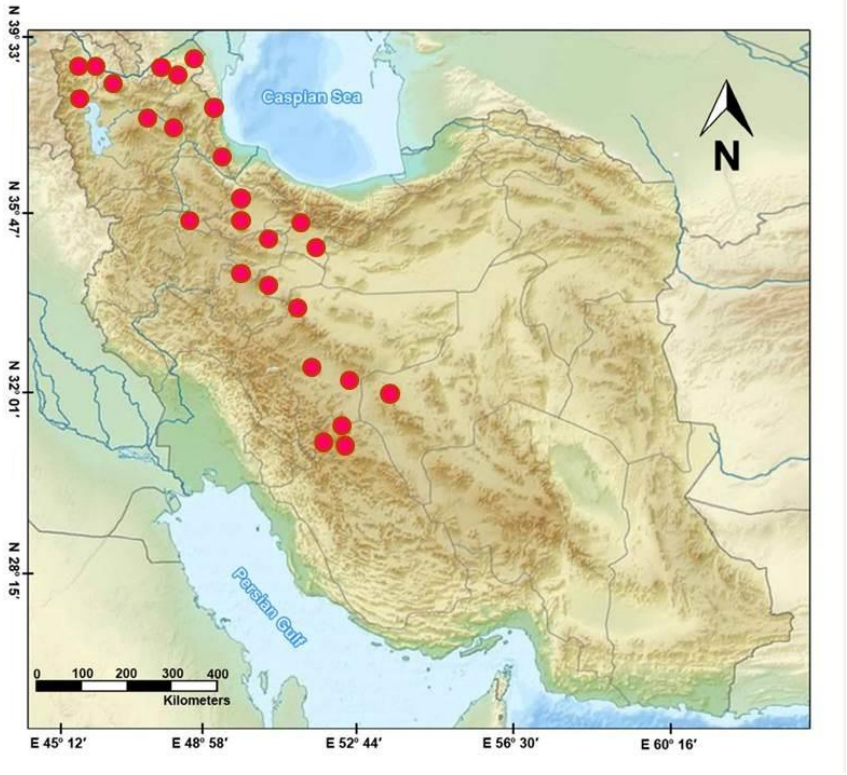

Figure 6. Distribution of *Phrynocephalus persicus* in Iran

***Phrynocephalus horvathi* MÉHELY, 1894**

Common Name: Horváth's Toad-headed Agama, Agama-ye sar-vazaqi-ye Horvath (P)

Type Locality: Aralich village at the base of Ararat Mountain in Armenia (Méhely, 1894 *a*, *b*; 1899).

Neotype: An adult male collected by Ivan S. Polyakov in 1879 in Aralich.

Distribution: West Azarbaijan and East Azarbaijan Provinces.

Diagnosis: Nostril directed forward, pierced in the central front part of small nasal scale; Nasal scale is not visible from above and upper nasals are twice larger and lower nasals three times larger than surrounding scales, separated from the first canthal scale by three small scales. Dorsal scales are smooth, heterogeneous, little larger than lateral scales, there is no distinguished longitudinal row of enlarged scales; The longest fourth toe, reaching 7 mm; Tail

is a little depressed at its base, with a small pit after the cloaca, tail scales are not arranged in whorls (Melnikov et al., 2013).

Remarks. In Some studies, all three forms geographically and morphologically were distinguished and considered *Ph. persicus, Ph. h. helioscopus,* and *Ph. h. horváthi* as distinctive forms (Carevskij, 1926; Terentyev and Chernov, 1936; Chernov, 1937; Terentjev and Chernov, 1949; Chernov, 1959). Later, S. A. Chernov, reviewed characters used for the taxonomy of toad-headed agamas and synonymized *Ph. h. horváthi* with *Ph. Persicus* and *Ph. h. helioscopus* (Terentjev and Chernov., 1949; Chernov., 1959). Some scientists consider *Ph. horváthi* and *Ph. persicus* as different taxa (Çiçek et al., 2011; Tosunoğlu et al., 2011; Melnikov et al., 2013) While other authors prefer to consider *Ph. horváthi* as subspecies of *Ph. persicus* (Arakelyan et al., 2011; Solovyeva et al., 2011; Milto and Barabanov, 2012). Melnikov et al. (2008) showed that *Ph. persicus* and *Ph. horváthi* are not identical forms and distinguished them from each other and from *Ph. helioscopus* (Melnikov et al., 2008). Length of the body and tail and distance between nostrils are important morphological characteristics that separated *Ph. persicus* from *Ph. horváthi*. In *Ph. horváthi* tail is thin and longer than the body (even longer and thinner than in *Ph. helioscopus*), in *Ph. persicus* tail is usually shorter or equal to the body length (SVL) (Melnikov et al., 2013).

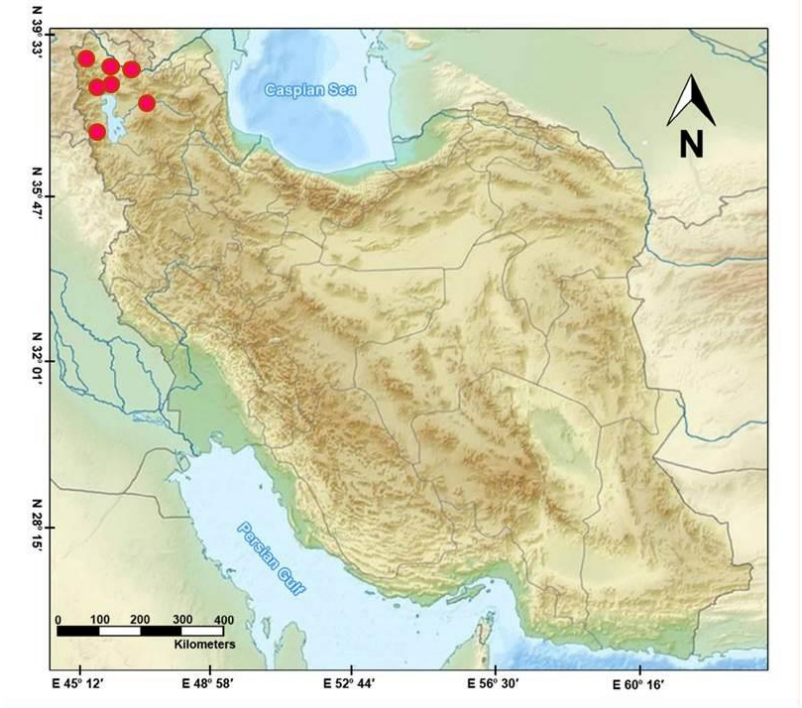

Figure 7. Distribution of *Phrynocephalus horvathi* in Iran

***Phrynocephalus mystaceus* (PALLAS, 1776)**

Common Name: Secret Toad-headed Agama

Type Locality: Arenosis Naryn and deserti comani, Naryn steppe on the north coast of Caspian Sea.

Distribution: Populations of *Ph. mystaceus* are distributed in the Caspian Basin, with an isolated population in northeastern Iran (Khorasan Razavi, South Khorasan, and Semnan Provinces). This species inhabits Sand dunes in association with *Tamarix* and other psammophilous shrubs and grasses.

Diagnosis: A large, fringed, cutaneous fold at an angle of mouth; well-developed lateral and medial fringes on digits; tail equal to 92-114 percent of the snout-vent length.

Remarks: Because of uncommon morphology, Eichwald, 1831 placed the large-sized, sand-dwelling *Phrynocephalus mystaceus* in an independent subgenus *Megalochilus* (Ananjeva., 1986) but this was not accepted by subsequent researchers. The nuDNA analysis suggests that *Ph. mystaceus* is a sister-group concerning the Middle-Eastern *Ph. interscapularis*-group (*Microphrynocephalus*), *Ph. Scutellatus,* and the Arabian *Ph. arabicus*– *Ph. maculatus*-group (Macey et al., 2018). Nevertheless, the phylogenetic position of this species is still conflicted and unresolved (Pang et al., 2003; Macey et al., 2018; Zhao, 1993; Dunayev, 1996; Arnold, 1999). Overall, Barabanov and Ananjeva (2007) presented three subspecies of *Ph. mystaceus*: the first, *Ph. m. mystaceus* (Pallas, 1776), from eastern Ciscaucasia, Caspian region and northwestern Kazakhstan (Ananjeva et al., 2004), the second, *Ph. mystaceus galli* Krassowsky, 1932, known from Transcaspian Region and Middle Asia from Turkmenistan, Uzbekistan, Kazakhstan, to northeastern and eastern Iran and adjacent areas of Afghanistan (Anderson, 1999; Ananjeva et al., 2004). Krassowky (1932) split *Ph. mystaceus* into European nominative subspecies *Ph. m. mystaceus* (Pallas, 1776) and Middle-Asian subspecies *Ph. m. galli* Krassowsky, 1932 that later upgraded to full species by Ananjeva et al. 1987 “1986. The third, *Ph. mystaceus aurantiacocaudatus* Semenov & Shenbrot, 1990, inhabits eastern Kazakhstan and western China. Semenov & Shenbrot, 1990 described this new subspecies based on morphological data and chromatic differentiation that afterward was synonymized with *Ph. m. galli* by Barabanov and Ananjeva (2007).

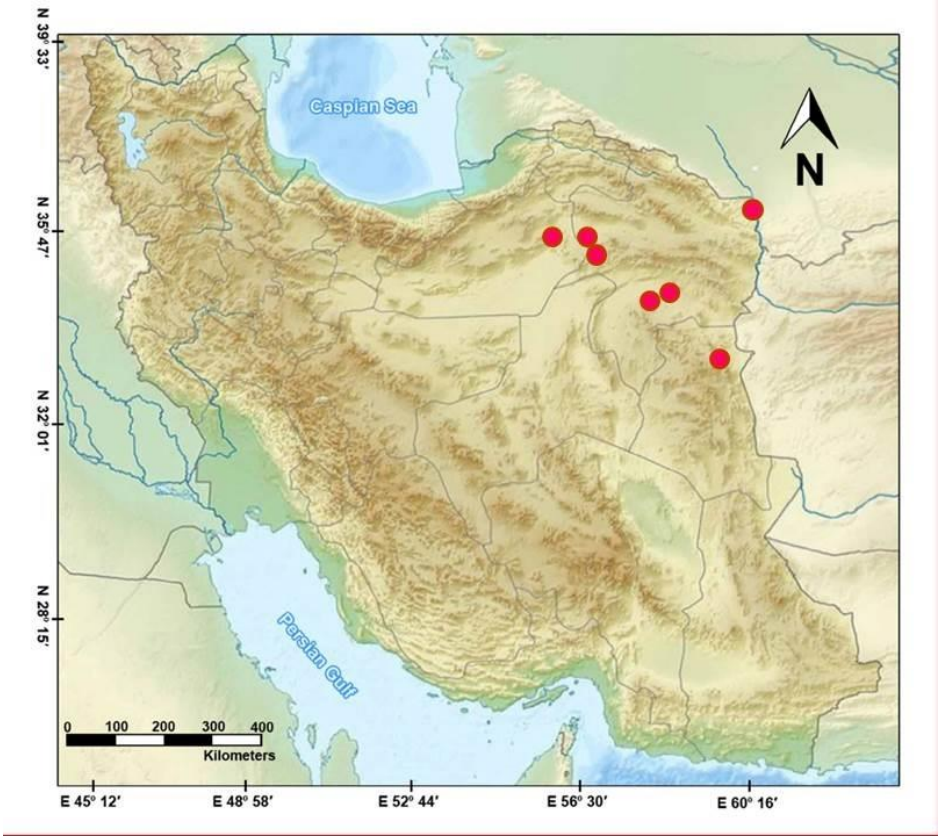

Figure 8. Distribution of *Phrynocephalus mystaceus* in Iran

***Ph. vindumi* GOLUBEV, 1998**

Common Name: Vindum's Toad-headed Agama

Type Locality: Iran, Khorasan Province 35 km North of Gonabad on road to Torbat-E. Heydariyeh

Distribution: From eastern deserts of Khorasan through the Helmand River basin of Afghanistan and desert basins of Baluchistan, Pakistan.

Diagnosis: Dorsal scales enlarge vary gradually from flanks to the mid-dorsal line, homogeneous; nasal shields in contact; no spinose scales on neck or back of the head; both sides of the fourth and outer aspect of third toes strongly fringed; three scales separate nasals from upper labials; two or three suborbital scales, none larger than adjacent scales; no dark-margined dorsolateral stripe between fore- and hind limbs. Tail 119-132 percent of snout-vent length(Anderson, 1999).

Remarks: Solovyeva et al. (2014) based on their molecular study and morphological data of Arnold (1999) suggested that small psammophilous species of southern Central Asia, Turan, and the Middle East, including *Ph. interscapularis, Ph. sogdianus*, and *Ph. ornatus*, constituted a distinct group and erected new subgenus *Microphrynocephalus* for these species (Solovyeva et al., 2014). Solovyeva et al. (2018) proposed two alternative taxonomic decisions;

recognizing the whole of a clade containing the *Ph. interscapularis*-group (subgenus *Microphrynocephalus*), *Ph. arabicus–Ph. maculatus*-group, *Ph. Scutellatus*, and *Ph. mystaceus* (subgenus *Megalochilus*) as *Megalochilus* or splitting it into several smaller taxa, including *Megalochilus*, *Phrynosaurus*, *Microphrynocepahlus*, and an unnamed taxon for the *Ph. arabicus– Ph. maculatus* species group. Because of the lack of samples of this *Phrynocephalus* clade, they suggested that further taxon sampling and additional nuDNA-markers need to be evaluated before making subgeneric changes in the interest of maintaining taxonomy stability (Solovyeva et al., 2018b). In Macey et al. (2018) consistent with both mitochondrial DNA and nuclear RAG-1 DNA analyses, *Ph. clarkorum*, *Ph. ornatus*, and *Ph. luteoguttatus* populations form a clade that within this clade two well-supported groups appear *Ph. clarkorum* and *Ph. ornatus* and both *Ph. luteoguttatus* populations (Macey et al., 2018). They elevated *Ph. o. vindumi* to species status as *Phrynocephalus vindumi*. Based on mt-DNA parsimony analysis, *Ph. vindumi* appears in a sister position to the clade containing *Ph. interscapularis* and *Ph. sogdianus*. *Ph. vindumi* occurs on the northeastern portion of the Iranian Plateau and *Ph. ornatus* occurs south of the Hindu Kush in Afghanistan and southwestern Pakistan (Macey et al., 2018).

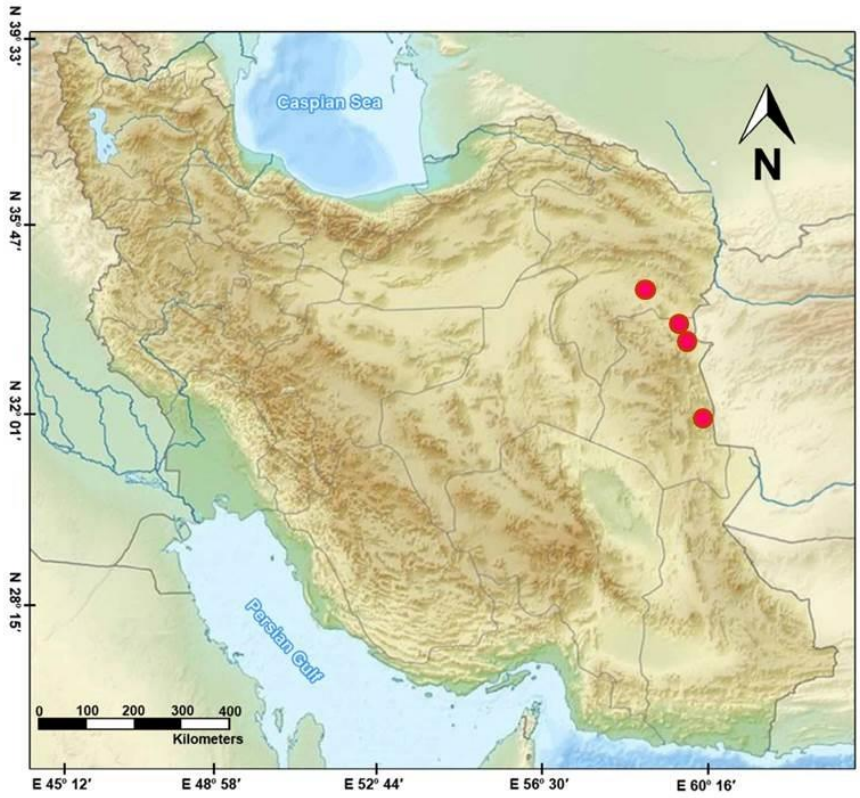

Figure 9. Distribution of *Phrynocephalus vindumi* in Iran

***Phrynocephalus lutensis* Kamali and Anderson, 2015**

Common name: Lut Desert Toad Headed Agama

Type Locality: Rig-e Yalan, Dasht-e Lut, Kerman Province, near the junction of Kerman, South Khorasan, and Sistan va Baluchistan Provinces.

Distribution: Its distribution is only known from the type locality, Rig-e Yalan, Dasht-e Lut, Kerman Province, near the junction of Kerman, South Khorasan, and Sistan & Baluchistan Provinces.

Diagnosis: Dorsum without upraised swollen scales; dorsal and ventral scales separating by the prominent fold on lateral sides of the body; dorsal scales subequal, smooth in general appearance, homogeneous, not keeled; flanks without enlarged scales; nasals not in contact and separated by 1–3 small scales; tail 106–119 percent of SVL (snout-vent length) (Kamali and Anderson., 2015).

Remarks: No molecular studies have been performed on *Ph. lutensis*. Based on the morphological study it appears to be similar to *P. euptilopus* Alcock & Finn 1896 and *P. luteoguttatus* Boulenger 1887. It can be distinguished from *P. helioscopus* and *P. persicus* by having smooth and homogeneous dorsal scales and from *P. maculatus* and *P. arabicus* by its distinctive color pattern, a black third of the tail, and presence of strongly fringed scales on both sides of the third and fourth toes (Kamali &Anderson., 2015).

Figure 10. Distribution of *Phrynocephalus lutensis* in Iran

Concluding Remarks: Three new species of *Phrynocephalus* were described from Iran since 2013; *Ph. ahvazicus* occurs in the Ahvaz plains, south-western Iran, *Ph. ananjevae* from the Zagros Mountains, and *Ph. lutensis* in the wind-blown sandy area from the Lut Desert. Macey et al. (2018) recognized all previous subspecies of *P. maculatus* as full species. Based on this study *Ph. maculatus* occurs in the central Iranian plateau. It is separated from *Ph. arabicus* and *Ph. longicaudatus* by the Zagros Mountains. *Phrynocephalus scutellatus* takes a position in a clade including the Arabian species group (*Ph. arabicus*, *Ph. longicaudatus*, and *Ph. maculatus*). In some studies *Ph. persicus* De Filippi, 1863, *Ph. Helioscopus* and *Ph. horváthi* Méhely, 1894 have been identified as distinct forms. While other studies considered *Ph. horvathi* as a subspecies of either *Ph. helioscopus* or *Ph. persicus*. Three subspecies of *Ph. mystaceus* are distributed in two main geographic areas in Central Asia, and northeastern Iran; *Ph. m. mystaceus*, *Ph. m. galli*, and *Ph. m. khorasanus* Solovyeva, Dunayev, Nazarov, Radjabizadeh & Poyarkov, 2018. *Phrynocephalus vindumi* has been upgraded as a full species and occurs in the northeastern regions of the Iranian Plateau, while *Ph. ornatus* occurs in the south of the Hindu Kush in Afghanistan and southwestern Pakistan.

Key to the species of the genus *Phrynocephalus* in Iran

1a. Large fringed cutaneous fold at angle of mouth . . . . . *Phrynocephalus mystaceus*

1b. No cutaneous fold at angle of mouth 2

2a .Dorsal scales heterogeneous, small scales intermixed with strongly enlarged scales 3

2b. Dorsal scales subequal, homogeneous, Sides of head and neck without projecting, fringe-like scales; no fringe of scales on posterior margins of thigh or tail; no enlarged scales along flank 6

3a. No half-moon shaped red patch on each scapula region. . . . . .*Phrynocephalus scutellatus*

3b. A half-moon shaped red patch on each scapular region 4

4a. A distinct transverse fold of skin across back of neck . . . . . *Phrynocephalus helioscopus*

4b. Usually no transverse fold of skin across back of neck. 5

5a. a longitudinal nuchal row of 3-8 mucronate tubercular scales, tail shorter or equal to the body length . . . . . *Phrynocephalus persicus*

5b. No distinguished longitudinal row of enlarged scales, tail thin and longer than the body . . . . . *Phrynocephalus horvathi*

6a. Tail without jet black crossbars ventrally, tip of tail black or gray 7

6b. Tail with 4 or 5 jet black crossbars ventrally, tip of tail not black nor gray 11

7a. Usually 4 or even 5 lateral rows of scales above supralabials counted at anterior edge of eye; Largest individuals exceed 60 mm SVL, Tail 130–160 percent of snout-vent length; distal tail less than 3rd black, or tail not tipped with black . . . . . *Phrynocephalus maculatus*

7b. Usually 3 or occasionally 2 horizontal rows of scales above supralabials counted at anterior edge of eye 8

8a. Largest individuals exceed 60 mm SVL, distal 3rd or more of tail black; number of internasals between nasals usually 2 or more . . . . . *Phrynocephalus lutensis*

8b. Largest individuals less than 60 mm SVL; distal tail less than 3rd black, or tail not tipped with black; usually 3 or occasionally 2 horizontal rows of scales above supralabials counted at anterior edge of eye, Snout rounded, tail variable in length and color 9

9a. Enlarged thorny scales on the dorsal side of the body, forming distinguishable crest on the neck, short tail, shorter or equal to the body, in males slightly longer and short extremities; scales on the extremities not keeled; without jet-black tail tip; longitudinal row of enlarged scales along the vertebrae; large distance between nostrils (up to 5 scales in one row) . . . . . *Phrynocephalus ananjevae*

9b. No crest on neck; tail distinctly longer than body, without longitudinal row of enlarged scales along vertebrae 10

10. Small body size; long tail both in males and females; uniform coloration of dorsal parts without patches on head and dorsum; coloration of the ventral white in life in calm condition, and distal half black and proximal half is white without pattern in alerted animals . . . . . *Phrynocephalus ahvazicus*

11. No light stripe along sides of body; three suborbital scales of about equal size. . . . . *Phrynocephalus vindumi*

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