

# A review on the genus *Trapelus* Cuvier, 1817 (Sauria: Agamidae) in the Iranian Plateau

Golnaz Eftekharzadeh<sup>1</sup>, Nasrullah Rastegar-Pouyani<sup>1\*</sup>, Eskandar Rastegar-Pouyani<sup>2</sup>

<sup>1</sup>Department of Biology, Faculty of Science, Razi University, Kermanshah, Iran

<sup>2</sup>Department of Biology, Hakim Sabzevari University, Sabzevar, Iran

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## Abstract

The genus *Trapelus* Cuvier, 1817, belonging to the subfamily Agaminae, is described with 13 species. There are absolutely four species in Iran: *T. agilis*, *T. ruderatus*, *T. sanguinolentus* and *T. persicus*. Within the vast distribution range of *Trapelus*, current and past climate and vicariance events have significantly influenced their diversification patterns and distributions. Recently, the first and the most comprehensive assessment based on molecular genetic analyses within *T. ruderatus* in western Asia including Iran, Turkey, Syria, and Iraq, has shown that Iranian populations have slight divergence whereas are undoubtedly isolated from Turkey's population. Also, this study introduced the populations of southern Iraq as belonging to *T. persicus*. In this review, we have tried to have a complete examination and comparison based on all of the available relevant literature about the taxonomy, phylogeny, evolutionary history, and biogeography of the genus *Trapelus* in the Iranian plateau and neighboring regions, as well as we examined the controversial nomenclature changes and their reasons in some species and subspecies of this genus. We will also give a brief overview of our unpublished dissertation on comparative morphology and dimorphism in the genus *T. ruderatus*. In the end, we present an identification key based on the latest changes in the classification and taxonomy of the genus.

**Key words:** *species, Iranian plateau, systematics, Zagros Mountain.*

## INTRODUCTION

The family Agamidae composed of about 350 species and 50 genera that inhabit the old world (Uetz et al., 2022), including continental Africa, Australia, and Southern Asia, with some extending into the warmer regions of Europe (Pal et al., 2018). The centers of origin of agamid lizards have been hypothesized in The Southeast Asian-Indonesian and Australian-New Guinean tectonic plates by Moody (Ananjeva N. B, 2011a.). Also, new studies on the Asian fauna using molecular methods suggested that taxonomic diversity in agamid lizards, particularly in South and Southeast Asia to be higher than was estimated before (Ananjeva, 2011). One of them is the genus *Trapelus* Cuvier, 1817 belonging to the subfamily Agaminae Gray, 1827 of the family Agamidae. Based on the phylogenetic, morphological, and fossil data, it can be concluded that the ancestors of the Agaminae subfamily occupied Africa through the Arabian Peninsula (Kissling, 2016). Melville et al. (2008) confirmed the Gondwanan origin of the subfamily Agaminae in the Indian subcontinent. They also concluded that the early radiation of Central Asian Agamids is related to the onset of drying during the Late Oligocene and Early Miocene. Moody

revised the genus *Trapelus* Cuvier, 1817 in the family Agamidae, (Ananjeva, 2011) later for a more inclusive assessment; these studies were followed by Frost and Etheridge (1989). Molecular and phylogenetic analysis can increase the understanding of the composition of genera of agamid lizards, solve the problem of phylogenetic evaluation of morphological characters, and contribute to creating identification keys (Ananjeva et al., 2011). Four species of *Trapelus* occur in Iran: *Trapelus agilis* (Olivier, 1804), *Trapelus ruderatus* (Olivier, 1804), *Trapelus persicus* (Blanford, 1881), *T. megalonyx* (Gunther, 1865), and *Trapelus sanguinolentus* (Pallas, 1814) (Rastegar-Pouyani, 2008, Ananjeva, 2013, Shahamat et al., 2020). In addition, *T. agilis isolepis* has recently been considered as a full species based on molecular investigation by Shahamat et al. (2020). *Trapelus* are unique lizards with short and thick heads, powerful legs, comparatively long tails, a small, deeply sunk tympanum with spiny scales above the ear opening, and a well-formed acrodont dentition for feeding on a wide range of foods. The genus *Trapelus* has not been fully investigated, leading to considerable nomenclature complications (Rastegar-Pouyani, 2000, 2005). Based on extensive morphological work, including work on different populations of *T. agilis* covering almost all of its range, Rastegar-Pouyani (1999) reported four subspecies within this species complex: the nominal subspecies *T. a. agilis*, *T. a. pakistanensis*, *T. a. sanguinolentus* and *T. a. khuzestanensis*. Later *T. a. sanguinolentus* was raised to a full species (Ananjeva et al, 2013). This species complex has recently been investigated in Iran based on morphological and ecological features and molecular phylogeny (Shahamat et al, 2019, 2020). Genetic distances between different populations based on two mitochondrial genes (Cytb and ND2) suggest that some of them are obviously differentiated from the others (e.g *T. khuzestanensis*, *T. isolepis*).

## TAXONOMIC ACCOUNT

### Order Squamata Opperl, 1811

### Family Agamidae Gray, 1827

### Subfamily Agaminae Gray, 1827

### Genus *Trapelus* Cuvier, 1816

The genus *Trapelus* is a Saharo-Sindian (Arabian) genus that encompasses about 15 species (Wagner, 2011). The genus occurs in the deserts and steppes of North Africa, the Arabian Peninsula, Southwest and Central Asia (Rastegar-Pouyani, 1999; Melville, 2008). The highest diversity of *Trapelus* occurs in the southern lowlands of Southwest Asia. However, it has one or more species widely distributed in the highlands of Central Asia (Anderson, 1999, Mohammed et al., 2015). Since the closest relative of most African *Trapelus* are found in Pakistan and India the most likely scenario is that their ancestors colonized Africa from Asia via the Arabian Peninsula, including Bab al-Mandab and Sinai (Kissling, 2016). An Agamid lizard of *Trapelus*, which has an Afro-Arabian origin (Macey et al., 2000), is an old genus and has been in Asia since the Miocene. The time of divergence between its species in Africa (*Trapelus savignii*), Arabia (*T. persicus*), the Iranian Plateau (*T. agilis*), and the Caspian-Aral Basin (*Trapelus sanguinolentus*) is estimated to be about 8.3 to 10.7 million years ago (MYBP) (Macey, 2004). Agaminae diverged due to Miocene events (Macey, 2006). The subfamily Agaminae, including the genus *Trapelus*, is probably the youngest of the African radiations, with diversification beginning around 23Mya (Kissling 2016). The molecular dataset suggests that the *Trapelus* complex originated in the late Oligocene (30 Mya) and then diversified during the early to middle Miocene (22-13 Mya) (Shahamat, 2019). The age of the genus *Trapelus* is estimated to be similar to *Phrynocephalus* (Melville, 2008). It is mainly found in bushes; Leviton (1963) also reports them in thorn bushes (in Iran); however, they have limited climbing ability. Males are often perched on rocks, clay molehills, or other high places (Masroor, 2011). Habitat specifics have been reported to affect the locomotor's performance and thermoregulation (Scott 2005). Habitat preference may differ between males and females of the same species (Eskandarzadeh et al., 2015). In general, the genus *Trapelus* has created significant difficulties for taxonomists due to the

numerous species complexes identified in this genus, just as, Rastegar-Pouyani has had challenges in examining its species (Wagner, 2011).

**Description:** Tympanum exposed, small with a deep acoustic duct; caudal scales are not arranged as oblique rows; Adults are medium-sized and only males with precloacal scales. Dorsal scalation is homogeneous or heterogeneous (Leviton et al., 1992). These lizards are characterized by short, thick heads (Moody, 1980), in contrast to the species of the genus *Agama*, and by deeply sunken tympanums with a few spiny scales around the ear opening (Shahamat et al., 2020). The larger head length to head width (HL/HW) ratio in males makes them stronger in biting and more successful in the battle between males and mating. (Rastegar-Pouyani et al., 2013; Eskandarzadeh et al., 2015). This sexual size dimorphism (SSD) is common in lizards, without a genetic basis and result from a wide range of local environmental processes. (Butler 2002). Sexual size dimorphism (SSD) patterns are in *Trapelus*, but it varies in different species. In some species, males are larger than females, and in others, females are larger than males (Eskandarzadeh et al., 2015), which will be discussed.

### ***Trapelus agilis* (Olivier, 1807)**

**Type locality:** Iraq, vicinity of Baghdad (Uetz, 2022).

*Trapelus agilis* commonly known as the Brilliant Ground Agama belongs to central and south Asia, such as the lowlands of southwest Iran (Rastegar-Pouyani, 1999, Khan, 2004; Heidari and Kami, 2009), southeast Pakistan, adjoining northwestern India and the only record in western India in the state of Gujarat since the late 1880s by Murray, was recently confirmed. This species was reported in habitats consisting of sparse xerophytic vegetation, and so far, no record of *T. agilis* has been recorded in the adjoining areas of Gujarat state (Joshi et al., 2017). Also, this challenging and widespread *T. agilis* complex in the Caspian-Aral Basin is divided into two different populations by the Caspian Sea (Macey, 2004; Rastegar-Pouyani, 1999, 2005; Shahamat, 2020). In Iran, the most extensive distribution is in the central and eastern regions of the plateau (Yosefzadeh et al., 2021). According to Mertens (1969) and based on the comparison of morphological characteristics of samples from Baluchistan (small, pale, long-legged, and large scales on the crown and temporal region), Karachi, and Kandahar, *T. agilis* is a composite of several species. Nilson and Andr n (1981) accepted the subspecies identifications of *Trapelus agilis* in the Iranian plateau. Moody (1980) determined *agilis* and *isolepis* as valid species. Although Anderson 1999 did not believe use of subspecific names for the *T. agilis* complex, some authors considered the three subspecies *T. a. agilis*, *T. a. isolepis*, and *T. a. sanguinolentus* in this complex (Anderson, 1999). Rastegar-Pouyani, 2005, regarded *T. a. isolepis* as a synonym of *T. a. agilis*. Traditionally, four subspecies are recognized within the clade: *T. a. sanguinolentus*, *T. a. khuzestanensis*, *T. a. agilis*, and *T. a. pakistanensis* (Rastegar-Pouyani, 2005). *Trapelus a. agilis* from central Iranian Plateau, southern Afghanistan, and southwestern Pakistan; *T. a. sanguinolentus* from northeastern Iran, northern Afghanistan, and the Central Asian Republics of the former USSR as well as Dagestan; *T. a. khuzestanensis* from the lowland southwestern Iran; and *T. a. pakistanensis* from southeastern Pakistan as well as adjoining northwestern India. The analysis was based on significant metric and meristic characters and with a multivariate approach, especially PCA and CVA. The cluster analysis results confirm the existence of several distinct morphotypes that are in agreement with different taxonomic entities (Rastegar-Pouyani, 2005). Rastegar-Pouyani, (1999) believed that there were no accurate records of *T. agilis* from Iraq and introduced the new locality in the city of Isfahan (about 110 km southeast). However, since syntypes still existed, Ananjeva et al. (2013) retained the original type locality as it appears in Olivier's (1804) description. This complex with high genetic diversity diverges into several clades on the Iranian Plateau and Central Asia; the vicariance and dispersal events are the reasons for their species' differentiation from the late Oligocene (Rastegar-Pouyani, 2005; Shahamat et al., 2020). The first population separated from the central continuum as the western clade was *Trapelus ruderatus* (22Mya); *Trapelus persicus* diverged in 18 mya, and finally, *T. sanguinolentus* isolated at approximately 16 mya. (Shahamat et al., 2020).

Based on molecular phylogeny, *Trapelus agilis* (*sensu lato*) can be divided into six genetic lineages in the Iranian plateau. The classification status of the studied populations was investigated using mitochondrial genetic markers. Different genetic markers are suggested for further help (Shahamat et al., 2020). Adaptation to the local conditions and geographic isolation by the uplifting of the Alborz, Zagros, and Kopet Dag mountains are main reasons for the isolation populations in Iran (Rastegar-Pouyani, 1999). The Western Zagros Mountains, northeastern and northwestern parts of the Central Iranian Plateau have the highest number of lizard species (Kafash, 2020). Bhatnagar et al. (2012) suggested that males and females are different in habitat selection, the males choose a shelter under rocks or bushes, and the females dig a burrow to live inside; as a result, the males have a more remarkable ability to change color to avoid a predator. Morphological characters and color patterns are different in both sexes; for instance, males have longer heads and thicker tails than females. In females, the dorsal region of the body has segmented transverse stripes with red or sombrous orange backgrounds. A dark blue color, mainly on the chest, flanks, and gular sac, and a black patch in the shoulder fold has been seen in males (Rastegar-Pouyani, 1998). However, the phylogenetic and taxonomic relationships of this complex are controversial. The key to identifying the subspecies of the *T. agilis* complex is provided bellow.

**Description:** This specie differs from all described Iranian congeners by its dorsal scalation homogeneous, subequal in size, without larger scales among them, and disposed of in irregular rows, the scales gradually become smaller towards the flanks, 52–103 scales around the middle of the body; gular sac variable, sometimes strongly developed in males to reveal the blue color; males with callous pre anal scales. The dorsal pattern is dark orange or red in gravid females. The female's body size is usually smaller than males and often has further scale counts in different body parts" (Rastegar-Pouyani, 2005).

## SUBSPECIES ACCOUNTS

### *T. a. agilis* (Olivier, 1807)

One of the distinct subspecies within the complex is *T. a. agilis*, distributed in the central Iranian Plateau, southern Afghanistan, and southwestern Pakistan, the distribution of these subspecies in the Plateau of Iran is in the southwest, central and northwest regions (Rastegar-Pouyani, 2005). *T. a. agilis* in southwestern and Central Iranian Plateau is the nominative subspecies (as the central core of the complex, which is morphologically most similar to *Agama agilis*, Olivier's syntypes) (Rastegar-Pouyani, 2007). It has the longest divergence time of the other populations, which is consistent with molecular analysis (Shahamat et al., 2018). Eco-geographical barriers had separated other populations such as *T. a. khuzestanensis*, Qom, and southeastern Iran from the central continuum (Rastegar-Pouyani, 1999). Ecological and morphological approaches also confirmed these differentiated populations (Shahamat et al., 2019). In morphological characters, the principal components include SVL (scales between eyes across the head), HL (length of the head), SAM (scales around the mid-body), and also the number of preanal callose scales and supralabials were significant characteristics. Since beneficial features such as morphological traits need more time to be selected by the natural selection mechanism after ecological niche separation, it can conclude that investigated groups did not have enough time to acquire differentiated morphological traits (Shahamat et al. 2019). The color changes of this species vary depending on the amount of sunlight; for example, it is darker in the cold or shade. Its habitat is a flat, open desert with clay or less sandy soil and scattered bushes or hills covered with vegetation (Minton, 1966). This species is characterized by having nuchal and temporal scales small; ear above with pointed scales; dorsal scales more or less equal in size, keeled; lateral and ventral scales slightly smaller than dorsals, keeled (indistinctly 76–103 keeled and mucronate around the body in Iran (Leviton & Anderson, 1963). tail round, slender, evenly tapering, with oblique scale rows. MASROOR 2012 has observed these characteristics in Pakistan; Males with gular sac and a row of 9-11 callose preanal scales; males and females of nearly equal size, male SVL to 110.2 mm, tail 176.3 mm; female SVL to 119.0 mm, tail 175.0 mm. A medium or short and often compressed tail in males (about 1.3-1.65 body length) and a unique

color pattern in many Iranian plain's populations (yellowish cream with distinct or indistinct dorsal cross-stripes) (Rastegar-Pouyani, 1999).

***T. a. isolepis* (Boulenger, 1885)**

Type locality: "between Magas and Bampur, Iran"(Uetz,2022)

The populations of *T. a. isolepis*, distributed in eastern and southeastern Iran, southern Afghanistan, and south and western Pakistan, situations in areas east of the Hub River (in the southeastern range of the range) and in some areas adjacent to the northwestern Indian desert may differentiate it, with the river acting as a barrier to its distribution in the west. However, its geographical isolation does not always guarantee divergence (Rastegar-Pouyani, 2005). This group has been synonymized with *T. a. agilis* by Rastegar-Pouyani (1999). However, this author's multivariate analysis (especially PCA and CVA) in 1999 confirmed *T.a. isolepis* as a new taxon. In the cluster analysis, *T. a. isolepis* is placed as a subgroup of *T.a. pakistanensis*. It presents a three-grouped pattern that is less compatible with the conditions of geographic diversity within the *T. agilis* complex than the four-grouped pattern in the previous analysis. In addition, the clustering method is much more subjective than the ordination techniques (Rastegar-Pouyani, 2005). In a survey of two mitochondrial genes by Shahamat et al., 2020, they found that the highest distance of 15.1% for the ND2 gene exists between *T. isolepis*, which shows that this population is well differentiated from the rest of the *T. agilis* complex, which may be influenced by adaptation to local conditions. Considering the high genetic distance for the southeastern clade, including a local type population of *T. a. isolepis* (Boulenger 1885) in both the Baluchistan regions of Iran and Pakistan, suggested that this clade should become *T. isolepis*. It is currently considered as a subspecies (*T.a. isolepis*) which is separated from the main subspecies (*T.a. agilis*) by different morphological traits including body size medium to large (Max SVL about 105 mm), 60–85 scales around the body; weakly moderately keeled, strongly mucronate, dorsal scales with a rather abrupt change from the larger scales of the median to the smaller lateral (Rastegar-Pouyani, 2000). Molecular genetic analyses are in progress, and the results will be published in forthcoming papers.

***Trapelus agilis khuzestanensis*, Rastegar-Pouyani, 1999**

Khuzistan Ground Agama

Type locality: Iran, Khuzistan Province, 5 km northwest of Haft-Gel on the road to Shushtar. This subspecies has been named based on its distribution area in the lowlands of southwest Iran, Khuzestan province, which is sympatric with *Trapelus persicus* in these areas. However, the exact boundary between the nominal subspecies and this species has not been carefully studied (Smid, 2014). This species presumably also occurs in the bordering areas of Iraq (Rostegar-Pouyani, 1999). One of the most important and prominent factors that play a role in the evolution and divergence of this subspecies is vicariance; after the orogeny of Zagros in the late Miocene, a great variety of ecosystems with significant differences arose due to the complex topography of Zagros and its elevation changes (Mostafavi, 2021). Due to this orogeny event, *T.a. khuzestanensis* in southwestern Iran was isolated from the *T. a. agilis* to adapt to local conditions through natural selection. Rastegar-Pouyani, 1999 for solving the patterns of geographical diversity within and among the four mentioned species, employed uni- and multivariate analysis using 18 valuable morphological characteristics. All populations of this vast range were divided into four distinct groups of subspecies, including *T.a. khuzestanensis*. Given the morphological traits, this subspecies is separated from other populations by having more scales around the body, about 80-97; also, dorsal scales are slightly keeled and smaller as if Leviton and Anderson (1961) introduced the variation in the scale rows of different populations as an important statistical factor, a shorter head, and neck; dorsal scalation almost heterogeneous, small scales in dorsal and ventral; the mean number of subdigital lamellae under the fourth toe significantly lower; keeled or rogues upper head scales; one or two rows of callose preanal scales (absent or slightly developed in females); strongly compressed tail in males, and a particular dorsal coloration (yellowish-grey-cream with weak or without reddish-brown cross bars).

The morphological results of Shahamat et al., 2019 based on 15 morphological characters (the number of preanal callose scales and supralabials were the most important variables), also confirmed the

separation of *T.a. khuzestanensis* from other central and northeastern groups. Also, the study of the ecological niche of *T. a. khuzestanensis* announced the separation of this group due to local adaptations and geological history. Ecological niche modeling result covers the habitat suitability of the current distribution range of *T.a. khuzestanensis*. Since after the differentiation of ecological niches, the selection of more valuable characters by natural selection requires more time (Nosil et al. 2005), morphology and ecology cannot confirm each other in the grouping and similarity of groups Shahamat et al. 2019.

Since morphology cannot show a high distinction among all populations of the species, Shahamat et al. 2020 investigated molecular markers based on sequences of two mitochondrial genes (Cytb and ND2) to report phylogenetic relationships, divergence times of the lineages, and intraspecific differentiation within this complex. *Trapelus agilis khuzestanensis* populations with the highest percentage of genetic distance (40%) in the Cytb gene indicated the most significant potential divergence to reach a separate species. Finally, they suggested considering the Persian Gulf's and southeastern Iran's coastal populations as distinct clades. *T.a. khuzestanensis* is the only subspecies in the *Trapelus agilis* complex, its morphological, ecological, and molecular results confirm each other to reach the full species level (Shahamat et al., 2019, Shahamat et al., 2020). However, the author suggested different taxonomic methods, such as karyotype analysis, microsatellite analysis, and geometric morphometrics, to improve the taxonomic status of the *T. agilis* complex on the Iranian Plateau. Figure 1b illustrates the distribution of these subspecies on the map.

#### ***Trapelus agilis pakistanensis*, Rastegar-Pouyani, 1999**

Type locality: Gaj-River, Kirthar Range, southeastern Pakistan

The distribution of *T. agilis pakistanensis* is limited to the semi-desert regions of southeastern Pakistan to the border of the Indian Territory, which is parapatric with *T. agilis* in its eastern areas in Baluchistan province. The naming of this subspecies is based on its distribution area, which is mainly limited to Pakistan. The distribution of this taxon is restricted to the west by the Hab River (Rastegar-Pouyani 1999). *T.a. pakistanensis* separated from the central chain in southeastern parts in the Pliocene (1.7-5 MYBP) and dispersed eastward to the northwestern Indian desert. Hence, the role of dispersal in the evolution of *T.a. pakistanensis* is prominent. But it is evident that still, much more work needs to be done, depending on many more specimens from critical areas in Pakistan, as well as between these populations to the west and the north, to resolve the problems in this wide-ranging complex (Masror, 2011).

Employing multivariate statistical techniques also shows the distinction of these subspecies and reconfirms the previous classification decisions (Rastegar-Pouyani, 1999, 2005). This species is usually distinguished by different key traits from other populations, which include: body and head sometimes compressed (not depressed) in males; males almost always with one row of callose preanal (rarely a second undeveloped row may present); females without callose preanal: dorsal scales relatively flat, subequal to homogeneous, distinctly keeled throughout and mucronate, grading into small dorso-laterals rather abruptly (especially in males), 67-83 around the body; ventral scales also often distinctly keeled in males; body and limbs often strongly slender and head distinctly pointed (in adult males); tail often strongly compressed in adult males, its length more than 1.55 of body length; the mean number of supra-labials and infralabials significantly lower than those of the other subspecies; a rudimentary nuchal crest often present (Rastegar-Pouyani 1999).



**FIGURE 1.** Distribution of *Trapelus agilis* complex in Iran: Orange circle: *T.a. khuzestanensis*; Black circle: *T.a. agilis*. Red circle: *T.a. isolepis*

***Trapelus sanguinolentus* (Pallas, 1814)**

Type locality: Terek River Valley.

*T. sanguinolentus* occurred in Russia (Dagestan), Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan, Tajikistan, Kazakhstan, and southward to the north Iranian Plateau (adjoined to Kopet-Dagh valleys), northern Afghanistan, northwestern China and in the west toward southeastern Europe (Ananjeva2011). Like an ecological barrier, the high mountain ranges of the Caucasus and Alborz prevent emigration of the European population from the south, where a continuous land connection does exist to *Trapelus* populations in Iran (Macey, 2004). Central Asian agamids, including the steppe agama (*Trapelus sanguinolentus*), despite their abundance in the region and thus their possible ecological importance, are relatively poorly studied (Novák, 2020). Furthermore, the Caspian-Aral basin clade is in a controversial taxonomic status, either in a separate species called *T. sanguinolentus* or subspecies *T.a. sanguinolentus* (Ananjeva, 2011). Nilsson and Andren (1981) explained that specimens from central (*T. a. agilis*) to northern Iran (*T. a. sanguinolentus*) have a rapid change in the mean number of midbody scales rows and accepted *T. a. sanguinolentus* as a subspecies. Recently, some authors have carried out significant studies with different ideas in the field of historical biogeography, phylogenetic relationships and genetic diversity, intraspecies diversity, morphological and ecological analyses, and taxonomic diversity on this species, which we compare and review. Macey et al. (2000b, 2006), with a phylogenetic analysis (1434 aligned positions) of 72 species and examination of two new sequences from ND1 to COX1, generated parsimonious trees that placed *T. sanguinolentus* as a valid species and its close relationship with *Trapelus savignii* were identified. Likewise, 10.7-13.9% sequence divergence (mitochondrial DNA segment from ND1 to COX1) between *Trapelus* species in Africa (*T. savignii*), Arabia (*T. persicus*), Iranian plateau (*T. agilis*), and Caspian-Aral basin (*T. sanguinolentus*) was calculated (Macey et al.,



2000), which estimated the time of divergence among *Trapelus* species to be 8.3 to 10.7 Mya, indicating that this genus has been in Asia since the Miocene. (Macey 2006)

There are also taxonomic disagreements about the status of the isolated European population of *Trapelus*. Ananjeva and Tsaruk, 1987, considered the European populations as distinct subspecies of *T. sanguinolentus* (*T.s. sanguinolentus*) and also named the Central Asian populations *T. s. aralensis*. Bannikov et al., 1977, introduced the European and Asian populations in the Caspian-Aral basin as the full species *T. sanguinolentus*, and Wermuth, 1967 considered it as a subspecies. Since the Caspian-Aral basin populations have always been identified as one species or one or two distinct subspecies from the Southwest Asian populations of *T. agilis*, the examination of these populations by evaluating allozyme data shows that these species do not show distinctive forms. Also, its low genetic diversity indicates the recent distribution of this genus throughout the Caspian- Aral Basin. Finally, the results suggest these populations as a single taxon, a distinct species of *T. sanguinolentus*, or a subspecies, *T. a. sanguinolentus* (Macey 2004).

Rastegar-Pouyani, 2005 by analyzing the multivariate approach, examining the significant metric and meristic characters, and considering the ecological and geographical barriers in *T. sanguinolentus*, identified the northeast group of Iran as one of the most extensive groups in the *T. agilis* complex. Despite the wide distribution in all populations of this group, they are very similar and homogeneous in almost all morphological aspects. This is probably due to one or more recent invasions from the southern parts of the range to the northern and northeastern regions. Although this population is geographically separated from the western shores of the Caspian Sea, it has not reached the necessary morphological differentiation. An intermediate form is also distributed in this area as the contact zone between these two groups. These hybrid populations, which indicate the gene flow between this taxon and other subspecies in the introgression regions, do not affirm the taxonomic designation belonging to the nominal subspecies. Melville et al., 2008 within a phylogenetic framework, sequenced a 1200 bp region of mitochondrial DNA and a 1200 bp nuclear gene (RAG-1), including inter- and intraspecific sampling across Central Asian Agamids. The results showed that *T. sanguinolentus* is probably the only species with no apparent genetic structure due to its recent introduction and rapid dispersal in Uzbekistan and Kazakhstan. Therefore, this species was introduced as belonging to the genus *Phrynocephalus*, which has a long and complex history in eastern Kazakhstan. Also, the age of both genera is estimated to be the same. Pyron et al., 2013 presented a new phylogenetic estimate for squamate species with a dataset containing 12,896 bp of 12 genes, including seven nuclear and five mitochondrial. In the case of the genus *Trapelus*, they proposed species limits and estimated that species such as *T. pallidus* may represent populations in other species. Also, the phylogenetic tree shows that *T. sanguinolentus* is placed next to *T. mutabilis* and is further away from *T. agilis*. In 2019, Shahamat et al. investigated the ecological and morphological characteristics (three metrics and 12 meristics) of the *Trapelus agilis* complex. Among the 15 morphological characters, the number of pre-anal callose scales and supralabials were the most significant variables. Based on that, the groups of eastern Iran, *sanguinolentus*, Central Khorasan, and Khuzestan were distinguished from other populations. As well as, based on the ecological analysis, one of the clades that are separated from all groups is *T. sanguinolentus*, and the groups of Central Plateau, Eastern Iran, and East-Central Plateau cannot be isolated from each other. They discovered that morphology and ecology disagreed in the grouping and similarity of groups and did not have the same results. They suggested that the lack of sufficient time to complete morphological differentiation and the constant climatic conditions of the Zagros Mountain range did not have enough evolutionary pressure to differentiate populations, and the difference between molecular, morphological, and ecological consequences is raised.

Shahamat et al., 2020, using the nucleotide sequence of two mitochondrial genes (Cytb and ND2) (total length 1322 bp), investigated the phylogenetic relationships and intraspecific differentiation of the *Trapelus agilis* complex. They reported the paraphyly of *T. sanguinolentus*, which had previously been introduced as a species, as its population was in the *T. agilis* species complex, a fact that was declared for



the first time. Meanwhile, based on molecular phylogeny, Iranian populations were divided into six genetic lineages. The time of separation of *T. sanguinolentus* from other populations (due to the closing of the Paleo-Tethys and the forming of the Kepeh Dagh Basin) was estimated to be about 12Mya. These lineages are geographically isolated and the genetic distance between them is more than 9.9%, indicating their separation at the species rank. Although, their remarkable similarity in morphology, (Rastegar-Poyani, 1999; Rastegar-Poyani, 2005; Shahamat, 2019) does not properly reflect their genetic differentiation. However, it is possible that genetic differentiation between groups could be reflected in characteristics other than, morphology. In a comprehensive study by Novák et al., 2020, basic morphological features, signaling, and agonistic behavior in relation to body condition and lifespan in *T. sanguinolentus* have been investigated. A comparative study of behavior with other subspecies in Central Asia and the Iranian plateau is suggested, which can be useful in deciding the status of this species.

In our opinion, considering all the studies and controversial results about such complexes, it can be practical and useful to consider the following in the final taxonomic decisions. Although taxonomies contribute to a better understanding of geographic variation, species, and taxonomic distinction, since the description of subspecies, there has been disagreement about its necessity (Gippoliti, 2013, Shannon et al 2014). Considering the confusion in the definition of subspecies, some disciplines, such as herpetology, have many authors who reject the classification of subspecies and do not support it to understand evolutionary divergence and conservation (Shannon et al 2014). Amadon, 1949, and Shannon et al. 2014 stated that a population is considered subspecies when 75% of the population's morphological characteristics are outside 99% of the range of other populations. Genetic results regarding the validity of subspecies often conflict with morphological data (Phillimore, 2006). Especially in reptiles, disagreement has been reported (Bryson et al., 2007; Burberink et al., 2008; Daza et al., 2009; Blatti et al., 2011). However, in cases such as the three subspecies of *Trimeresurus flavomaculatus* where genetic data support recognized subspecies, the authors do not recommend taxonomic changes (Slanders et al., 2004). A notable case is a difference in genetic distance values for the height of a subspecies or its collapse, for which there is no universal threshold value and a standard method for species-subspecies boundary detection should be developed (Miralles et al., 2010).

Howlitchek 2012 proposes the concept of subspecies to unify taxonomy and limit taxonomic inflation. Although many herpetologists oppose the description of new subspecies or even the protection of existing subspecies, most ornithologists use subspecies ranking in conservation and identification studies, the evolutionary divergence of distinct populations, and species without warranted classification. Evidence suggests that there is a level of divergence along the path of speciation where lineages are recognizably distinct but not full species, and this level corresponds to the rank of subspecies. Subspecies differ from other subspecies of the same species but can be mixed with them. However, species are distinct in sympatric and allopatric states (Howlitchek 2012). Thus, subspecies are "a stage in the process of allopatric speciation". Since species are taxonomic levels, they are considered for analysis, protection aims, and evolutionary studies, as a result, taxonomic inflation within species is a concern (Howlitchek 2012, Phillimore 2006), and by converting subspecies to the species level, viable units no longer indicate distinct evolving entities. (Howlitchek 2012). To solve taxonomic problems, increasing the possibility of sequencing whole genomes, instead of sequencing a few hundred base pairs of mitochondrial DNA, allows for better analysis of physical and physiological characteristics (Lippert et al. 2017), especially if descriptions of morphological accuracy, habitats, and high-resolution photos are considered (Uetz, 2019).



FIGURE 2. Distribution of *T. sanguinolentus* in Iran.

***Trapelus ruderatus* (Olivier, 1804)**

Type Locality. Near Esfahan, Esfahan Prov., Iran.

The former type locality, established by Rastegar-Pouyani (2000), between Bandar-e-Ganaveh-Borazjan (50°45'E, 29°35'W), Bushehr Province, SW Iran, (Ananjeva et al. 2013).

*Trapelus ruderatus* is a widespread, disjunct, with multiple populations, distributed in stony habitats with little vegetation and high-altitude areas. *T. ruderatus* is a species that was recognized by this name after Moody's revision (1980). The *T. ruderatus* complex traditionally has three subspecies: *T.r. ruderatus*, *T.r. baluchianus* and *T.r. megalonyx* (or *T. megalonyx*) Günther, 1864 (Rastegar-Pouyani,1998). The eastern subspecies of this species in Iran, *T. r. baluchianus*, is no longer available and comes under the synonymy of *T. megalonyx* (Rastegar-Pouyani, 2000). *T. megalonyx* has not any zone of intergradation with *T. ruderatus* in Iran due to a distance of more than 500 km and the absence of intermediate populations (Rastegar-Pouyani, 2000). Its distribution after the split of *megalonyx* was limited to Jordan, Syria, and Lebanon through Iraq and S Turkey to W Iran, westwards extending to central Anatolia. In Iran, it has been well recorded in the Zagros Mountain range in most western provinces (Ilam, Kermanshah, and Lorestan). It penetrates the Alborz Mountain range in Tehran province. Toward east, it is distributed in the central parts of the southern plateau of Iran to the south of Shiraz (Anderson, 1999; Rastegar-Pouyani, 2000, Smid et al., 2014). Based on morphological traits, the population of this species in Iran can be easily identified from *T. agilis* and *T. persicus* with key characteristics such as more depressed and smaller body size, shorter limbs and head, more heterogeneous dorsal scalation with nail-like large scales dispersed on the dorsal surface of the body, and the approximate scarcity of gular sac. In central and southcentral regions of the Iranian plateau, it overlaps with *T. agilis*. Thus they are sympatric species

(Rastegar-Pouyani, 2007). There is a 13% percent overlap between the two groups, which shows that the distribution of the two species has little overlap in southern Iran (Hosseini Yousefkhani, 2016). *T. persicus* and *T. ruderatus* were reported sympatric in the alluvial area of Dehloran city at an altitude of 200 meters, also in Bushehr, Fars, and Esfahan Prov. (Fathinia et al. 2009). Since Olivier (1804) described the *T. ruderatus* complex based on a single specimen, taxonomic status and type locality have remained problematic. This uncertainty prompted Rastegar-Pouyani (2000) to examine the holotype of *T. ruderatus* (Olivier, 1804) and compare it with other related specimens of *Trapelus*. In his investigations, he found that the holotype of *T. ruderatus* is identical to the syntype of Blanford's *Agama persica*. As the name "*ruderatus*" (Olivier, 1804) predates "*persicus*" (Blanford, 1881), all populations of *T. persicus* are preferable to the original name "*ruderatus*." Furthermore, the holotype of De Filippi's *Agama lessonae* was not conspecific with Olivier's *Agama ruderata*, requiring it to be considered a distinct taxonomic entity. Since *T. lessonae* is the oldest name, the population names were changed from *T.r. ruderatus* to *T. lessonae* and designated a lectotype and type locality. He also showed that the western radiation of the complex in Iran is geographically and morphologically distinct from the eastern radiation (*T.r. baluchianus* and *T. megalonyx*). Since *T. megalonyx* Günther, 1864, was described before *T.r. balochianus* (Smith, 1935), all the populations of these two taxa in Afghanistan, Pakistan, and possibly southeast Iran must be named under the nominal and original name of *T. megalonyx* (Rastegar-Pouyani, 2000). Ananjeva et al. 2013 provided solutions to avoid nomenclatural problems and prevent further complications in interpreting the taxonomic status of different forms of the genus *Trapelus* in molecular phylogenetic studies. They agreed with Rastegar-Pouyani on the similarity of the *Agama [Trapelus] ruderata* holotype (MNHN 2610) to *T. persicus*. Still, they considered that the original description of *Agama ruderata* was not based on a single holotype. Still, at least two syntypes, one of them agrees with the diagnosis of the original Atlas. A second syntype completely corresponds to the definition of *Agama ruderata* Olivier, 1804. A point that Rastegar-Pouyani (2000) ignored and did not provide any reference to Olivier's Atlas (1804) (Atlas Livraison: Pl. 29: Fig. 2) and therefore presented a different taxonomic decision. In the latter case, according to previous herpetologists, Boulenger, 1885; Wermuth, 1967,) seems to be the best decision is to designate the holotype of *Agama lessonae* De Filippi 1865 as a neotype *T. ruderatus* Olivier, 1804. Also, the status of *A. lessonae* De Filippi in 1865 as an objective synonym of junior *A. ruderata* Olivier, 1804, is confirmed according to Boulenger (1885:348). Thus, the type locality of *A. ruderata* becomes "Presso Spahan" (De Filippi, 1865) in Isfahan Province, in the center of Iran. Finally, based on the mentioned cases, the nomenclature modifications were not accepted, and the previous names are valid. Older holotypes are often abbreviated and not up to today's standards. They may not accurately represent the current condition of the specimens, significantly when they added later species to the same genus. As a result, the original types often require re-description. Such cases lead to challenges in such research (Uetz, 2019).

In our unpublished study in 2011, we investigated the morphological variation within this species in Iran. We examined 177 individuals of *T. ruderatus* in terms of 40 metric and meristic traits. Three OTUs were determined based on the presence of the Zagros Mountains as an ecological barrier in its east, west, and center. We found that diameter's ear (DE) in the male population of *T. ruderatus* in the center and west of the Zagros Mountains are significantly higher than in the east of it. The Discriminant Functional Analysis (DFA) showed that the specimens of these three populations do not overlap much, and the specimens are placed in separate groups. Finally, Cluster analysis by Ward's method completely separated the populations of the east of Zagros Mountain from the west and the center. Mountain uplifting might also be associated with forming biodiversity gradients, shaping an association between habitat heterogeneity and species richness (Kafash, 2020). Using molecular and morphological data and a comprehensive sampling in Iran and neighboring areas, Yousefabadi et al. 2021 conducted a phylogenetic analysis. Their study revealed that the populations of this species complex are divided into five distinct clades, of which three are in Iran including the populations of northwestern Iran (Azerbaijan provinces), western Iran (Kermanshah province), and Fars province in southern parts of the country. The other two groups were in southeastern Turkey and central-southern Turkey-western Syria. As Arabia collided with the Eurasian plate and as a result of a vicariant event about 8 Mya, the lineages of Northwest and West

Iranians and the lineages of Southeast Anatolia and South Anatolia-West Syria separated. More than 8% of the mean distance in the ND2 gene fragment among the Iranian clades revealed that these clades should be considered as distinct species. The morphological diversity and the high genetic distance between Syria, Turkey, and Iran populations of *T. ruderatus* indicate their high potential to reach a distinct level in species rank.

According to the niche divergence measurements, the habitats' differentiation between the sympatric *T. persicus* and *T. ruderatus* species was confirmed, and the most important environmental variables for the distribution of *T. ruderatus* were precipitation in the wettest and warmest months, temperature seasonality, and slope. The amount of rainfall is necessary for access to water, the growth of plants, and preparing a shelter for them, moreover the accumulation of insects that are an essential source of their nutrition (Hosseinian Yousefkhani, 2016). According to the habitat model and where most records are known, the most suitable habitat for this species is in Southeast Anatolia (Bird, 1936; Schmidt, 1939; Bodenheimer, 1944; Baçoğlu and Hellmich, 1970; Baran et al., 1989; Baran and Atatür, 1998; Baran et al., 2012)

The range of distribution of this adaptable species is wide from north to south and east to west, which is compatible with different habitats and altitudes. Anderson, 1999 pointed out that the variable ecological factors can be affected by the morphology of local populations which inhabits heterogeneous habitats. The Zagros Mountains limit the distribution of this species in Iran. The Zagros Mountain range acts as natural barriers and corridors for lizards that have restricted the distribution of this species toward the central plateau of Iran. (Ahmadzadeh et al., 2013; Gül, 2013; Hosseinian Yousefkhani et al., 2016; Kapli et al., 2013; Smidt & Frynta, 2012)

**Definition.** Body distinctly depressed; limbs relatively short; head roundish; caudal scales obliquely arranged; nostril below canthus rostralis; dorsal scales heterogeneous, back and flanks with scales of varying size intermixed; 66–125 scales around the middle of the body; a patch of enlarged scales on the upper surface of the thigh may be present; callose preanal scales in one, two or three rows; small patch of scales on the neck just posterior to occiput in which direction of imbrication is reversed, or no reverse imbrication; gular sac absent or very weakly developed in males, enlarged scales on the neck (rudimentary nuchal crest) absent, teeth 60. Dorsum sandy gray or grayish-brown, usually with 5 or 6 dark cross bars, interrupted by light vertebral ovoid spots, sometimes marked with very dark brown; sometimes up to three additional series of dark-edged spots on each side of the vertebral line; the tail also has dark bars, interrupted by light vertebral spots; the pattern is sometimes indistinct in males (Rastegar-Pouyani, 2000). In terms of sexual dimorphism in size, in smaller lizards such as *Trapelus ruderatus*, females have a larger size (female-biased), and the adaptation of the female body concerning the production of offspring (eggs) is the main determining factor for the larger size of the female. And in fact, fecundity selection plays a more influential role (Rastegar-Pouyani, 2013). Ahmadzadeh, (2008) reported it in open stony ground and in cropland with low weed vegetation in autumn.

### ***Trapelus persicus* (Blanford, 1881)**

Persia Agama

Type locality: Deh Bid and KáZRun.

*T. persicus* complex is known for the lowland regions and desert areas around the Persian Gulf and Mesopotamian Plain. Rastegar-Pouyani described *T. persicus* at an altitude of 300 meters elevation in hot and wet areas with 40 degrees temperature around Borazjan (75 km southwest of Kazerun) of Bushehr province, and he did not have any records in the valleys of the Zagros mountains around Kazerun (the other type locality). According to this author, the populations of *T. persicus* could not penetrate the Zagros Mountains and is restricted to its type locality from Deh Bid in the inner part of the Zagros Mountains to a new one in southern Iran, Fars-Bushehr provinces, the area southwest of Kazerun towards



FIGURE 3. Distribution of *Trapelus ruderatus* in Iran.

Borazjan, and considered the syntype collected from this area as the lectotype. Moreover, by re-evaluating the taxonomic status, he made major nomenclatural changes and replacements in the species and renamed all *T. persicus* populations to *T. ruderatus*. Later, this nomenclatural situation was analyzed and resolved some problems of the name-bearing type by Ananjeva et al. (2013), which returned the names to their previous state. In the Iranian plateau, this species belongs to the southern and southwestern regions, a habitat with alluvial plains and different vegetation, including low bushes and cultivated areas, which is entirely different from the habitat of *T. agilis*. In addition, the study and comparison of ecological niches have shown that the central plateau of Iran is not suitable habitat for *T. persicus*. As a result, the Zagros Mountains are a barrier to expanding its territory. The difference niches between the two groups were investigated, and their overlap was about 13% which can be concluded that both species are sympatric in the south of Iran, and *T. persicus* is distributed to a small zone. The results obtained from niche modeling suggest that the environmental conditions for *T. persicus* are restricted. The most significant variable for *T. persicus* is the warmest quarter rainfall since it is associated with water availability in arid regions of southern Iran. One of the special features of this species is that it is the largest species of the genus *Trapelus*. *T. persicus* complex includes two subspecies, *T. p. persicus* and *T. p. fieldii*. These two subspecies differ in the main metric and meristic characteristics of the dorsal pattern, snout-vent length, enlarged scales on the neck, and gular sac. In the southwestern plains of Iran, both subspecies may exist, although their exact distribution range and the degree of intergradation are unknown (Rastegar-Pouyani, 2005). *Trapelus persicus fieldii* (Haas & Werner, 1969) was collected from Abu Kamal (from Syria) near the Syrian-Iraqi borders for the first time. Its distribution range is in Iraq, Kuwait, Jordan, northern Saudi Arabia (Arnold, 1986; Leviton et al., 1992), and probably, southwestern Iran on the lowland coasts of the Persian Gulf. The type locality of *T. p. fieldii* is between Al-Qaysumah and Turaif, Saudi Arabia (Uetz, 2022).



In *T. p. fieldii*, the taxonomic traits such as a larger size, slenderer, and different color patterns of dark and bright longitudinal stripes, as well as a distinct and lighter vertebral pattern, have separated it from the main species, *T. p. persicus*. The subspecies' habitat is hard to wetland with *Nitraria retusa* shrubs, and the vegetation is mostly *Anabasis* sp. Males were recorded more than females on the region's highest rock (Zuhair, 2007). The type locality of *T. p. persicus* Deh Bid Kazeron, Fars province, south-central Iran. *T. p. persicus* was distributed in the Mesopotamian Plain in lowland Iraq and southwestern Iran, the northern Arabian Desert, and Jordan and expanded to the Persian Gulf and Saudi Arabia shores. It seems limited to the lowlands and has not penetrated the slopes and mountains of Zagros. *T.p. persicus* in southwest Iran (SVL: 85 mm) is smaller than *T. p. fieldii* (SVL: 135 mm), with faint and weaker lines and enlarged scales present in the midline of the neck less than in *T. p. fieldii*. According to the modeling, there is a possible hybrid zone between the two subspecies. Based on Morphological traits, *Trapulus* has a larger body size, longer tail than body length (smaller SVL/TL), and fewer ventral scales. The molecular genetic results confirmed the morphological differences between *T. persicus*, *T. ruderatus*, and *T. agilis*, as well as *T. persicus*, have shown the highest genetic distance from other populations. (Yusef abadi, 2021) According to the molecular study, the divergence time has been estimated as 18.8 mya between *T. persicus* and *T. agilis*. *T. persicus* represents the second clade at the base of the tree (Shahamat et al., 2020).

**Definition.** Dorsal scales strongly heterogeneous, back and sides with mixed scales of different sizes, 72–97 scales around midbody; ventral body scales distinctly keeled canthus rostralis and supraorbital ridge usually well developed; enlarged scales on the neck more or less grown, almost always, one row of preanal callose scales in males, which in females are weakly developed or missing; create a corrugating gray or light purple stripe on the neck and back as anterior oval vertebral spots linked, connected with darker brown lines stretching onto the dorsal surface of the head, or a noticeable dorsal pattern of dark and light longitudinal stripes, male with extent gular sac. A dark bar on the side of the neck develops across the temporal region to the eye, and a brown line crosses the head at the level of the anterior part of the orbits; almost males have a luminous body and an orange tail. Based on the evidence, it can be concluded that the body color change occurs in defensive and threatening situations, and the dorsal area of the tail turns brick red. In contrast, the sides, gular folds, the lower surfaces of the eyes, and especially the front limbs turn dark blue (Fathinia, 2011).

### ***Trapelus megalonyx* (Günther, 1864)**

(Ocellate ground Agama: Patta korh-kirla)

Type locality: vicinity of Ghazni, Afghanistan. (Utez,2022)

*Trapelus megalonyx*, the Afghan ground agama, distributed in some parts of eastern and southern Afghanistan, north-central Baluchistan, Sindh, and the Cholistan Desert in Punjab, Pakistan, collected up to an elevation of 1800 m. India and Perso-Baluch (Iranian-Pakistani) border (Khan,2003). Rastegar-pouyani 1998 believed that the specimens identified as *T. megalonyx* were synonymous with *Agama ruderata baluchiana*. This species was recorded in the semi-desert and mountainous habitat north and south of Ghazni, Afghanistan. Although there was no reliable report of this species in Iran until then, Werner reported *T. megalonyx* in 1895 in the southeast of Kerman province in Iran, and two records by Annandale from Sistan-Baluchistan Province, on the Iranian-Pakistani border. However, Rastegar-pouyani, 2000 by examining the difference in the heterogeneity of the dorsal scales in both species, believed that *T. r. baluchiana* is not different from the Afghan species, *T. megalonyx*, and considered them synonymous. He noted that *T. r. baluchianus* is a junior synonym of *T. megalonyx*. So, the name *T. megalonyx* includes all the previous populations of *T. r. baluchiana*, and it is no longer valid (Rastegar-pouyani, 2000).



FIGURE 4. Distribution of *Trapeus persicus* in Iran.

In the description of *T. megalonyx*, Günther (1864) pointed out that the claw nails are much longer, and Boulenger (1885) used this trait in her key to separate it. Still, this character is less common in other males and even less so in females and also juveniles, with the presence of 4 to 12 callose preanal scales in a single row in males, which were less developed in females, and having 67 to 84 scales around the middle of the body. At the same time, Milton considered it 71 to 88 scales in *T. megalonyx*, which was more in *T. r. baluchiana*, about 80–82 scales around the widest middle of the body, but after examining the holotypes of both of them, Anderson did not observe any significant difference.

One of the most recent records of *T. megalonyx* was in the protected area of Sirisha-Goji Torbat Heydarieh in the central region of Khorasan province in 2018 by Assadian Narenji et al, considering that it was not reported in this area before, it was verified as a new record. Considering the reclusive of the species, the author predicts the possibility of its presence in other regions of Khorasan. The key characteristics described were: heterogeneity of dorsal scales and homogeneity of ventral scales, 68–88 scales around the widest part of the body, callous preanal scales in a row, and males without gular sac.

**Diagnosis:** Nostril below canthus rostralis; dorsal scales heterogeneous, back with scales of varying sizes intermixed, enlarged scales not extending onto flanks; 68–88 scales around the widest part of the body; upper surface of thigh usually lacking distinctly enlarged scales, or with an area of large scales not intermixed with small scales; callose preanal scales in a single row; none of the neck scales with reversed imbrication; males without gular sac (Anderson 1999). Even more, Blanford (1875) believed Stoliczka's *Trapeus megalonyx* (from Sindh) is also *T. agilis* (Masroor, 2011).





FIGURE 5. Distribution of *Trapelus megalonyx* in Iran.

**Identification keys to the subspecies of *Trapelus agilis* complex** (Source: Anderson, 1974, Rastegar-Pouyani, 1998, Nasrabadi, 2017.)

- 1a.** Tail almost always round, two (or more) rows of callose preanal scales ..... **2**
- 1b.** Tail often compressed, often one or in the case of two row of callose preanal scales (pre anals absent or weakly developed in females) ..... **3**
- 2a.** Body size variable; 65-91 scales around body; dorsal scales subequal, weakly to moderately keeled, often strongly mucronate; ventral scales smooth or weakly keeled; usually 2, sometimes 3 (rarely 4-5) rows of callose preanals; background coloration variable; central Iranian Plateau, central and southern Afghanistan, southwestern Pakistan. .... *Trapelus agilis agilis*
- 2b.** Body size medium to large (Max SVL about 105 mm), 60–85 scales around body; weakly moderately keeled, strongly mucronate, dorsal scales with a rather abrupt change from the larger scales of the median to the smaller lateral.; ventral scales weakly keeled; Baluchistan, southeastern Iran, Pakistan, Afghanistan and northwestern India ..... *Trapelus agilis isolepis*
- 3a.** Body and limbs smaller than those of the other subspecies and sometimes slender not compressed; head and neck distinctly short; body scales smaller than those of the other subspecies; dorsal scales heterogeneous, weakly to moderately keeled, weakly mucronate; 80-97 scales around body; ventral scales slightly keeled; scales of posterior part of head and anterior part of neck reversely imbricated; upper head scales keeled or rugose; 14-19 upper and lower labials; background coloration yellowish grey-cream; lowland southwestern Iran ..... *Trapelus agilis khuzistanensis*
- 3b.** Body and limbs distinctly slender, sometimes compressed in males; dorsal scales subequal to homogeneous, distinctly keeled and mucronate, usually clearly set off from small dorsolateral; 67-83

scales around body; ventral keeled in adult males; no reversal imbrication of head and neck scales; upper head scales smooth; 12-16 upper and lower labials; background coloration often sandy grey: southeastern Pakistan and northwestern India. .... *Trapelus agilis pakistanensis*

**Key to the Iranian Species of the Genus *Trapelus*** (Sources: Rastegar-Pouyani, 1998. Masroor, 2011., Khan.2002,2003, Nasrabadi,2017)

- Dorsal scalation homogeneous, two (or more) rows of callose preanal scales

**1a.** Dorsal scalation homogeneous, subequal in size, without larger scales among them and disposed of in irregular rows, grading into progressively smaller scales of flanks, 52–103 around the middle of the body; gular sac variable, sometimes strongly developed in males; males with callous preanal scales. .... *Trapelus agilis*

**1b.** Body stout; 52-73 scales around body; all dorsal, ventral, and gular scales larger in size, homogeneous, strongly keeled and mucronate; almost always 2 rows of callose preanals; background coloration of males often dark sandy-grey; northeastern Iran, northern Afghanistan, Central Asian Republics, western coast of the Caspian Sea (Daghestan), western China.....*Trapelus sanguinolentus*

- Dorsal scalation heterogeneous, intermixed with larger scales, ..... 2

**2a.** Abdominal scales pointed; Largest dorsal scales more than twice the size of smallest; anterior oval vertebral spots linked together on neck and back, bordered by brown stripes extending onto dorsal surface of head, pattern variable in different populations; males with strongly developed gular sac; nuchal crest more or less developed; males with one row of callose preanal scales; canthus rostralis often well developed..... *Trapelus persicus*

**2b.** Body distinctly depressed; head roundish; limbs relatively short; nostril below canthus rostralis; abdominal scales smooth or very weakly keeled; largest dorsal scales about three times width of adjacent small scales, usually nail like, 66–125 around body; oval vertebral spots may or may not be distinct, sometimes contained within dark crossbars, not link into longitudinal stripe; enlarged scales on neck absent; gular sac absent or weakly developed in males .....*Trapelus ruderatus*

**2c.** Dorsal scales different in size and irregular in arrangement, enlarged dorsal scales pointed; largest dorsal scales about twice the size of the smallest; fewer than 100 scale rows around body; dorsum with reddish or orange ocelli with dark borders..... *Trapelus megalonyx*

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