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RESEARCH ARTICLE Open access

New records of *Androctonus* Ehrenberg, 1828 (Scorpiones: Buthidae) from Iran

Hossein Barahoei[1*], Mostafa Farmani[2], Mehran Shahi[3], Saideh Yousefi[4,5], Farzad Rahmani[6] & Madineh Abbasi[6,7**]

[1]*Agriculture Institute, Research Institute of Zabol, Zabol, Iran.*
[2]*Department of Parasitology and Mycology, Faculty of Medicine Tabriz University of Medical Sciences, Tabriz, Iran.*
[3]*Department of Medical Entomology & Vector Control, School of Public Health, Infectious and Tropical Diseases Research Center, Hormozgan Health Institute, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.*
[4]*Sirjan School of Medical Sciences, Sirjan, Iran.*
[5]*Student Research Committee, Sirjan School of Medical Sciences, Sirjan, Iran.*
[6]*Emergency and Trauma Care Research center, Tabriz University of Medical Sciences, Tabriz, Iran.*
[7]*Infectious and Tropical Diseases Research Center, Tabriz University of Medical Sciences, Tabriz, Iran.*

Abstract
Limited studies have been conducted on the scorpions of East Azarbaijan Province, resulting in the identification of seven Buthid species. The examination of *Androctonus* specimens collected from East Azarbaijan Province between 2021–2023 resulted in the identification of two new records, *Androctonus kunti* Yağmur, 2023 and *Androctonus turkiyensis* Yağmur, 2021. These two species were collected and described from east and south of Turkey respectively and recorded here for the first time from Iran. With the identification of *A. kunti* and *A. turkiyensis*, which before reported as *Androctonus crassicauda*, the total number of reported scorpion species in East Azarbaijan Province raised to eight, while the number of *Androctonus* species documented in Iran rose to six. Diagnostic characters of the two species and an identification key to Iranian *Androctonus* were provided.

Keywords: Fauna, *Androctonus*, taxonomy, morphology, Azarbaijan, Iran.

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INTRODUCTION

Fat-tailed scorpions of the genus *Androctonus* Ehrenberg, 1828 (Buthidae C. L. Koch, 1837) are easily distinguished by their thick and high metasomal segments. Its species are widely distributed in Middle East and Asia (Iran, Afghanistan and India) (Lourenço, 2008; Rein, 2025). Members of *Androctonus* have an extensive distribution throughout Iran (Barahoei et al., 2020). Although black specimens of this genus have been mostly classified as *Androctonus crassicauda* (Olivier, 1807), with Kashan as type locality, recent studies (Jafari et al., 2020; Ghavami et al., 2022; Barahoei et al., 2022a, 2025) have revealed significant morphological and genetic differences among various populations in Iran.

In recent years, several studies on the populations of this taxon in neighboring countries in the west of Iran have led to the description of three new species, including *A. sumericus* from Iraq, *A. turkiyensis* and *A. kunti* from Turkey (Al-Khazali & Yağmur, 2023; Yağmur, 2021, 2023). Study on populations residing in the highlands of the eastern mountain belt of Iran restulted in the description of *A.*

*Corresponding Author: ✉ : h.barahoei@uoz.ac.ir ;abbasi627@gmail.com

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rostami (Barahoei et al., 2025). The populations found in southwestern Iran were classified as *A. sumericus* (Barahoei et al., 2025). The yellow-coloured Iranian populations inhabiting the lowlands along the southeastern borders of Iran belong to *A. sistanus* (Barahoei et al., 2022a).

Limited studies have been conducted on the scorpions of East Azarbaijan Province, resulting in the identification of only seven species of the Buthidae (Barahoei et al., 2020, 2022b; Kovařík et al., 2022), one of which is *A. crassicauda* (Mohammadi-Bavani et al., 2017). The present study aims to conduct a faunistic survey on the populations of *Androctonus* in East Azarbaijan Province, Iran using morphological characters, and to determine their distribution range.

MATERIAL AND METHODS

Field work for this study was conducted in the East Azarbaijan Province from 2021 to 2023. Scorpion specimens were collected from the designated locations in both mountainous and plain regions, as well as five stations across various cities of the Province. Sample collection involved daily searches for scorpion shelters, burrow excavation, and night searches using UV light.

The collected samples were transferred to the laboratory of the Infectious Tropical and Disease Research Center at Tabriz University of Medical Sciences in the sampling containers by installing the specification labels. The morphological characteristics of different body parts were examined using reliable identification keys (Barahoei et al., 2025; Yağmur, 2021, 2023).

Photography was done using a Canon EOS 800D digital camera, and images were processed using Adobe Lightroom version 6.0 and Adobe Photoshop CS5.

The collected specimens are housed at the Research Institute of Zabol, Zabol, Iran (RIZ) and Infectious and Tropical Disease Research Center, Tabriz University of Medical Sciences, Tabriz, Iran (TBZMED).

RESULTS

The analysis of 34 specimens of *Androctonus* scorpions gathered from various areas within East Azarbaijan Province resulted in the identification of two species, namely *A. kunti* and *A. turkiyensis*, which represent new records for the fauna of Iran. The results of this study confirmed that the previous records of *A. crassicauda* from East Azarbaijan Province are mis-identifications.

Systematics

Family Buthidae C. L. Koch, 1837

Genus *Androctonus* Ehrenberg, 1828

***Androctonus kunti* Yağmur, 2023** (Figure 1)

Prionurus crassicauda: Birula, 1896: 232 (in part); Birula, 1904: 29 (in part).
Androctonus crassicauda: Yağmur et al., 2008: 14.
Androctonus crassicauda: Mohammadi-Bavani et al., 2017: 373-377.
Androctonus kunti Yağmur, 2023: 1-19, 79 figs.

Examined material (10♀, 15♂): ***East Azerbaijan Province*** - 1♀, **Jolfa** (38°56'28.50"N, 45°37'48.79"E), 18 October 2023, col.: M. Salami; 3♂, **Marand**, Yamchi (38°31'12.14"N, 45°37'50.94"E), 26 June 2023; 1♂, 23 July 2023, col.: M. Keykhali; 1♀ (Figure 1A-B), Yekan-e Kahriz (38°40'23.11"N, 45°24'25.70"E), 18 June 2023; 1♂, 20 July 2023, col.: M. Keykhali; 1♂, 23 June 2023, col.: Amirjani; 1♀, 1♂, Girag-sofla (38°32'34.40"N, 45°34'20.51"E), Jolfa, 18 July 2024, col.: M. Salami; 2♂, Kafiolmolk (38°08'18.58"N, 45°34'44.63"E), 22 July 2023, col.: Sarvari; 1♂, **Shabestar**, Dizaj-e-Khalil (38°09'10.07"N, 45°43'28.39"E), 24 July 2023, col.: H. Amirian; 1♀, Kūh-e Mīshū (38°28'19.95"N, 45°43'08.59"E), 23 June 2023, col.: M. Babaei; 1♂, Sis, 11 August 2024, col.: M. Babaei; 1♀, Ammand (38°01'37.87"N, 46°09'37.50"E), 13 July 2023, col.: M. Farhan; 2♀, **Tabriz**, Asbes (38°00'04.65"N, 46°07'10.32"E), 23 August 2022, col.: S. Asghari; 1♀, 1♂, Sari Zami (38°00'22.57"N, 46°19'27.83"E), 23 July 2023; 1♀, 20 July 2024; col.: Khodaparast; 1♀, 15 July 2023, col.: Arezoomand; 1♂, 20 July 2023,

col.: H. Razmjoo; 1♂ (Figure 1C-D), 10 July 2023, col.: V. Ghaderi; 1♂, 13 August 2024, col.: S. Kolahdooz.

Diagnosis

Medium to large sized, body overall colour brownish-black to black, chela manus wider than patella, fixed and movable fingers with 14–16 oblique rows of denticles, carapace covered with coarse and rounded granules on anterior part, pectines with 31–35 teeth in males, and 25–27 in females, ventrolateral carinae of metasomal segment V with 3–4 non-spaced large triangular denticles, dorsolateral carinae rounded with very swollen and large granules anteriorly, without granules posteriorly, anal arch with two large round lobes on lateral part, first lobe divided.

***Androctonus turkiyensis* Yağmur, 2021** (Figure 2)

Examined material (2♀, 6♂): ***East Azerbaijan Province***, 1♂, **Charoimagh**, Zaker Kandi (36°98'32.40" N, 47°13'00.08" E), 28 June 2023, col.: K. Habibi and M. Azizi; 2♀, 2♂ (Figure 2), **Malekan**, Bayqut (37°15'54.30" N, 46°04'50.92" E), 25 June 2022, col.: M. Zarrinfar; 1♂, Turaghay (37°05'13.96" N, 46°18'43.15" E), 28 August 2024, col.: E. Fathi; 1♂, Abbas Abad (37°09'46.25" N, 46°06'30.67" E), 16 July 2023, col.: Mokhtari; 1♂, **Maragheh** (37°09'11.29"N, 46°10'45.68"E), 20 August 2024, col.: M. Farmani.

Diagnosis

Medium to large sized, body overall colour dark brown, pedipalp slightly elongated, movable and fixed finger with 14–16 rows of oblique teeth, intercarinal area on carapace with large and sparse granules on anterior part, pectines with 30–33 teeth in males, and 26–27 in females, ventrolateral carinae of metasomal segment V with 1 large rectangular (in females) or 3–4 nonspaced large triangular denticles (in males), dorsolateral carina with granules anteriorly and smooth edge posteriorly, anal arch with two lobes in lateral part, first one rounded, large and always with a groove.

Identification key for *Androctonus* species occurring in Iran

1- Overall colouration yellow; metasomal segments IV-V and telsom black ……..… *A. sistanus*
- Overall colouration brown to black; all metasomal segments and telsom with same color …….. **2**
2- Overall coloration black; anterior part of carapace with coarse and dense granules; ventrolateral carinae of metasomal segment V without large denticles or with 3-4 large nonspaced denticles …… **3**
- Overall coloration brown; anterior part of carapace with large granules; ventrolateral carinae of metasomal segment V with 1-2 large triangular denticles or spaced 2-3 large denticles **5**
3- Ventrolateral carinae of metasomal segment V with 3-4 large nonspaced denticles; sternite VI without granule; distributed in northwest highlands of Iran ……..…… *A. kunti*
- Ventrolateral carinae of metasomal segment V without large denticles; middle part of median carina and end part of sub lateral carina in the sternite VI granulated ……..… **4**
4- Lateral surface of sternites III-VI smooth; intercarinal surface of sternite VII smooth or sometimes with some large granules; posterior lateral carina of carapace vestigial; distributed in eastern and southern highlands of Iran ……..……..… *A. rostami*
- Lateral surface of sternites III-VI covered with granules; intercarinal surface of sternite VII with fine and abundant granules; presence of posterior lateral carina of carapace; distributed in the center of Iran ……..…… *A. crassicauda*
5- Carapace on anterior part with coarse, flattened and dense granules; ventrolateral carinae of metasomal segment V with 1-2 moderate triangular denticles ……..…….. *A. sumericus*
- Carapace on anterior part with large, cuneiform and sparse granules; ventrolateral carinae of metasomal segment V with 1 large rectangular denticles in females and 3-4 large triangular denticles in males ……..…….…….... *A. turkiyensis*

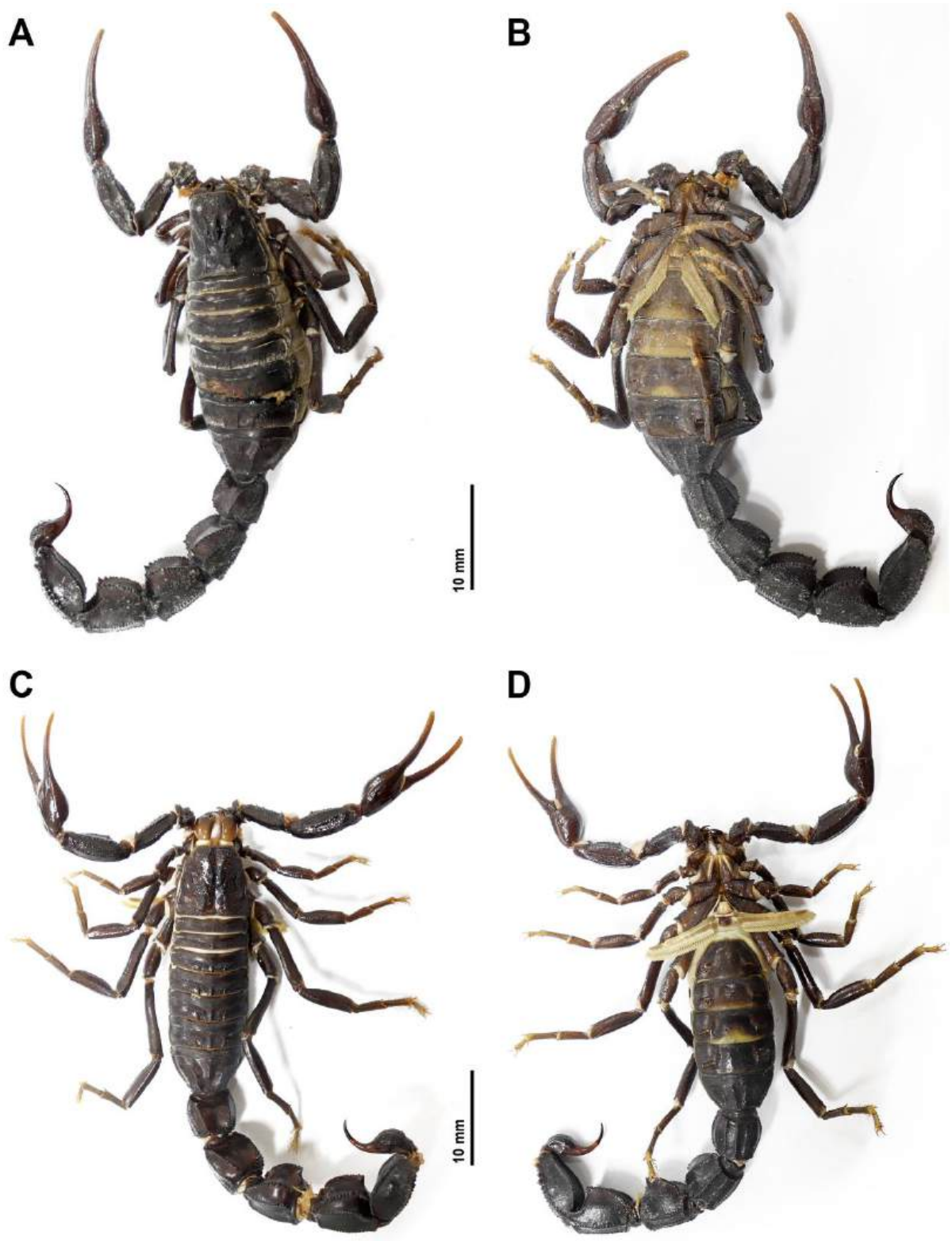

FIGURE 1. Adult specimens of *Androctonus kunti* Yağmur, 2023 collected from northwest Iran, female: A) dorsal view, B) ventral view; male: C) dorsal view, D) ventral view.

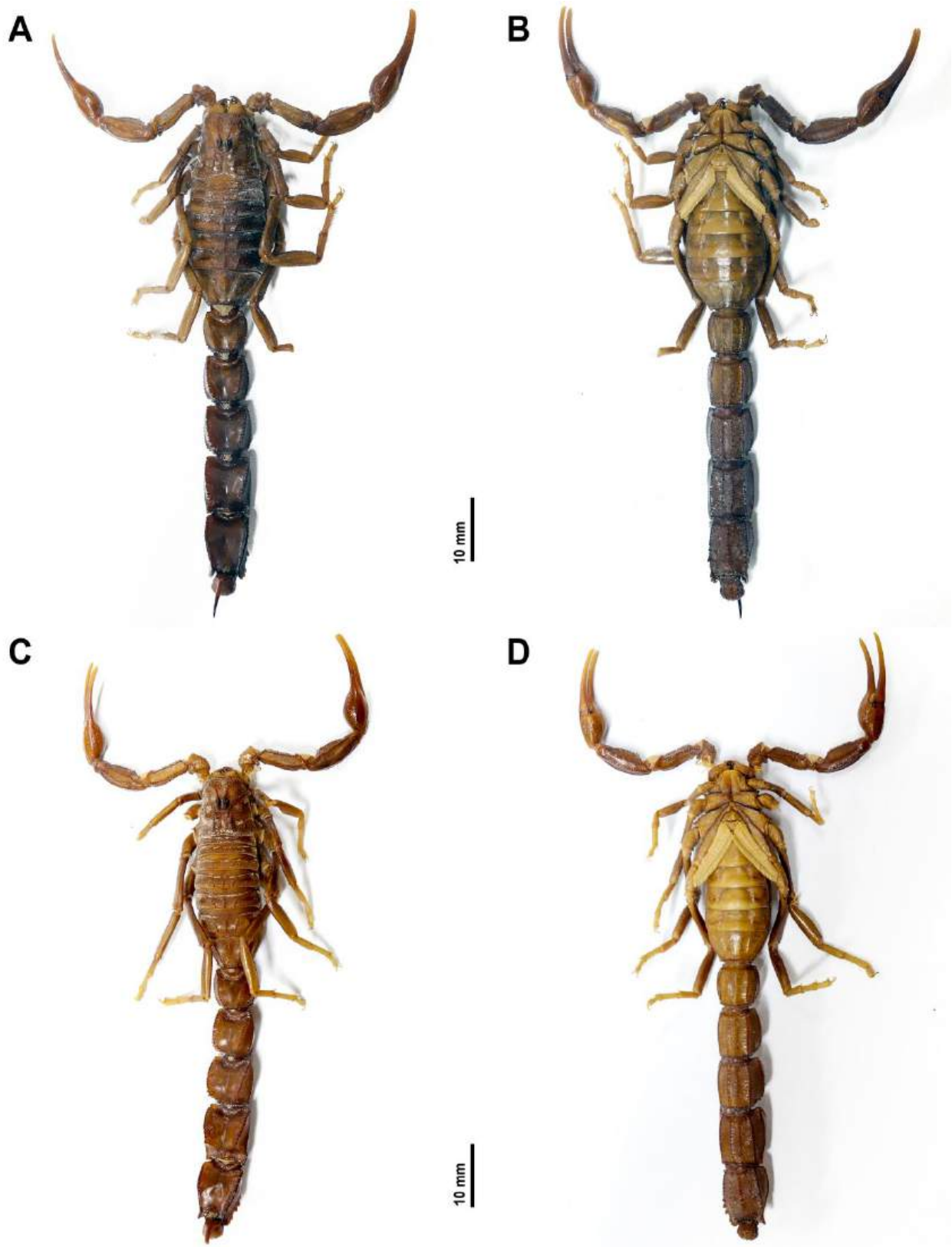

FIGURE 2. Adult specimens of *Androctonus turkiyensis* collected from northwest Iran, female: A) dorsal view, B) ventral view; male: C) dorsal view; D) ventral view.

DISCUSSION

To date, seven species of scorpions have been documented in the East Azerbaijan Province, all of which are classified under the family Buthidae, and all records of the genus *Androctonus* were assigned to *Androctonus crassicauda* (Olivier, 1807). Research on the *Androctonus* populations residing in East Azerbaijan Province (northwest Iran) has indicated that all specimens from this area are linked to *A. kunti* and *A. turkiyensis*. Therefore, it can be inferred that *A. crassicauda* is exclusively found in the central regions of Iran, located between the Alborz and Zagros mountain ranges (Barahoei et al., 2025).

The identification of *A. kunti* and *A. turkiyensis* has led to an increase in the total number of scorpion species reported in this Province to eight. Concurrently, the number of *Androctonus* species recorded in Iran has raised to six. It is essential to comprehend the distribution of different *Androctonus* species to ascertain their habitat conditions, mitigate the risk of scorpion stings, and formulate specific antivenoms designed for each species to ensure effective treatment.

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Checklist of Collembola (Hexapoda) from Iran, Part II: Entomobryomorpha

Masoumeh Shayanmehr[1,*], Rafael Jordana[2], Elham Yoosefi Lafooraki[3], Eliyeh Yahyapour[4], Mehdi Ghajar Sepanlou[5]

[1]*Department of Plant Protection, Faculty of Crop Sciences, Sari University of Agricultural Sciences and Natural Resources (SANRU), Mazandaran province, Iran.* m.shayanmehr@sanru.ac.ir
[2]*University of Navarra, Department of Environmental Biology, Pamplona, Spain.* rjordana@unav.es
[3]*Department of Plant Protection, Faculty of Crop Sciences, Sari University of Agricultural Sciences and Natural Resources (SANRU), Mazandaran province, Iran.* elham.yoosefi.@sanru.ac.ir
4Islamic Azad University, Arak branch, Agricultural Faculty, Entomology Department, P.O. Box 38135/567, Arak, Iran. eyahyapur@yahoo.com
[5]*Department of Soil Science, Faculty of Crop Sciences, Sari University of Agricultural Sciences and Natural Resources (SANRU), Mazandaran province, Iran.* sepanlou@gmail.com

Abstract
The order Entomobryomorpha is one of the four important orders of the Collembola (Springtails). These arthropods are distinguished from the rest of the Collembola by having the third abdominal segment larger than the fourth segment and having scales in some species. In this study, the list of Entomobryomorpha species (Collembola) in Iran has been prepared based on scientific sources related to Collembola reports between 2020 and 2025 and the materials examined in the present study. This checklist includes 139 species in 41 genera belonging to six families of the order Entomobryomorpha along with the materials examined and distribution in the world and Iran. Three species, including one species from the family Entomobryidae, *Lepidocyrtus lignorum* (Fabricius, 1775), one species from the family Tomoceridae, *Tomocerus asiaticus* Martynova 1969, and the species *Desoria kaszabi* Dunger, 1982 from the family Isotomidae, are new to the fauna of Iran. A list of Entomobryomorpha species, descriptions of new records, along with some images and a key to the Iranian species of the family Tomoceridae are provided.

Keywords: Mazandaran, Mesofauna, soil-living animals, taxonomy.

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INTRODUCTION

Order Entomobryomorpha Börner, 1913 (Collembola), the elongate-bodied springtails, are ubiquitous, species-rich, and diversified hexapods (Yu et al., 2022). They have long and slim bodies unlike Symphypleona and Neelipleona orders which are known as globular springtails and a reduced prothorax unlike Poduromorpha order which have a well-developed prothorax (Hopkin, 1997). The members of main groups of Entomobryomorpha are cosmopolitan so that occur in any terrestrial niches (Yu et al., 2022).

The study of Collembola fauna in Iran has been increasing over the last few years so that several species have been described or recorded from the country. As a result, the endemism among Collembola species of Iran is increasing. The list of Iranian springtails published by Cox (1982) includes 31 species in 13 genera of Entomobryomorpha. In the checklist of Collembola species of Iran by Shayanmehr et al. (2013), 56 species in 23 genera of Entomobryomorpha were reported, and this number were increased to 105 species in 34 genera in the next list (Shayanmehr et al., 2020b). Present work deals with the list of

*Corresponding Author: ✉ : m.shayanmehr@sanru.ac.ir

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Entomobryomorpha species based on published literature between 2020 and 2024 and the materials of present study.

MATERIAL AND METHODS

This checklist is based on the literature published between 2020 and 2025 and collected materials by authors. Leaf litter, soil, and dead wood were collected from various localities in Mazandaran province, North of Iran, specimens were extracted using Tullgren funnels and preserved in in 75–80% alcohol. To prepare microscopic slides samples were cleared in 10% KOH and mounted on Hoyer's medium. The identification of specimens was carried out using valid identification keys such as Potapov (2001), Fjellberg (2007), Jordana (2012), and Winkler et al. (2020). The examined materials are deposited in Entomology lab of Sari University of Agricultural Sciences and Natural Resources, Iran.

RESULTS

The checklist of Entomobryomorpha order of Iran is provided here alphabetically. In total, this order currently comprises 139 species, 41 genera, and six springtails families recorded in Iran. Three species are newly recorded for Iran which are denoted by an asterisk (*).

Order Entomobryomorpha Börner, 1913
Family Entomobryidae Schäffer, 1896
Subfamily Entomobryinae Schäffer, 1896
Genus *Calx* Christiansen, 1958

Calx kailashi Mandal, 2018
General distribution: India and Iran (Mandal, 2018; Ahmadi et al., 2023).
Distribution in Iran: Kurdistan (Marivan-Pirsafa) province (Ahmadi et al., 2023).

Genus *Coecobrya* Yosii, 1956

Coecobrya caeca (Schött, 1896)
General distribution: Australia, North America (Greenslade, 1992).
Distribution in Iran: Kerman (Mahan) province as *Sinella* cf. *coeca* (Schött, 1896) (Abdolalizadeh, 2018).

Coecobrya tenebricosa (Folsom, 1902)
General distribution: Cosmopolitan (Jordana, 2012).
Distribution in Iran: Isfahan and Mazandaran (Babol) provinces as *Sinella tenebricosa* Folsom, 1902 (Nematollahi et al., 2009; Alijani-Ardeshir et al., 2017).

Genus *Drepanura* Schött, 1891

Drepanura kirgisica Martynova, 1971
General distribution: Central and North Asia (Abdolalizadeh et al., 2019).
Distribution in Iran: Kerman province (Abdolalizadeh, 2018; Abdolalizadeh et al., 2019).

Drepanura pallens Rusek, 1981
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Fars province, synanthropic species (Semati et al., 2023).
Examined material: Mazandaran province, Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 2.

Drepanura tuxeni Nosek, 1964
General distribution: Palaearctic, Tajikestan (Rabieh et al., 2023).
Distribution in Iran: South Khorasan (Birjand) province (Rabieh et al., 2023)

Genus *Entomobrya* Rondani, 1861

Entomobrya albocincta (Templeton, 1836) in Templeton & Westwood 1836
General distribution: Europe, Mediterranean (Bellinger et al., 2024).
Distribution in Iran: Kohgiluyeh and Boyer-Ahmad (Cheram) province (Falahati Hosseinabad et al., 2011).

Entomobrya atrocincta Schött, 1896
General distribution: Europe, Mediterranean (Bellinger et al., 2024).
Distribution in Iran: Golestan (Gorgan), Kermanshah (Harsin), Mazandaran (Behshahr, Qaemshahr, Sari, Savadkooh) and Tehran provinces (Yahyapour et al., 2011; Yoosefi Lafooraki, 2014; Kahrarian, 2015, 2019; Darvish-Motevalli, 2016; Hosseini et al., 2016a; Qazi & Shayanmehr, 2016; Yahyapour et al., 2020; Ghasemi Charati et al., 2022; Vahedi Moghadam et al., 2022).

Entomobrya corticalis (Nicolet, 1842)
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Golestan (Golestan National Park), Guilan, Mazandaran (Sari), and North Khorasan (Darkesh-Jozak forest, Zoeram village) provinces (Cox, 1982; Khanahmadi, 2018; Yahyapour et al., 2018, 2019; Mehrafrooz Mayvan et al., 2022).
Examined material: Mazandaran province, Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 3; Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 2.

Entomobrya handschini Stach, 1922
General distribution: Europe, Poland to Iran to the south east of Black Sea (Baquero et al., 2008).
Distribution in Iran: Kermanshah (Harsin, Kermanshah, Sarab-e-Nilufar) and Tehran provinces (Moravvej, 2003; Qazi & Shayanmehr, 2014; Kahrarian et al., 2014; Kahrarian, 2015, 2019).

Entomobrya indica (Baijal, 1955)
General distribution: Tibet, India (Jordana, 2012, Yadav et al., 2018).
Distribution in Iran: Kerman (Sirch village) province (Abdolalizadeh, 2018; Abdolalizadeh et al., 2019).

Entomobrya lanuginosa (Nicolet, 1842)
General distribution: Central and Nothern Europe (Jordana, 2012).
Distribution in Iran: Central, East Azarbaijan, Guilan, Mazandaran, and North Khorasan (Darkesh-Jozak forest) provinces (Cox, 1982; Mehrafrooz Mayvan et al., 2022).

Entomobrya lindbergi Stach, 1960
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Guilan (Rasht), Kermanshah (Derkah, Harsin, Sarab-e Nilufar, Sahneh), Mazandaran (Sari), and Tehran provinces (Daghighi et al., 2013; Moravvej, 2003; Qazi & Shayanmehr, 2014; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Kahrarian, 2015, 2019; Kahrarian et al., 2014).
Examined material: Mazandaran province, Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 4; Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 3; Neka, Lemon

village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 2; Sari, Marzrud village, 36º14′20″ N, 53º39′10″ E, 46 m a.s.l., 18-May-2020, leg. E. Yahyapour, n= 81; Sari, Abmal forest, 36º42′52″ N, 53º06′00″ E, 10 m a.s.l., 24-May-2020, leg. E. Yahyapour, n= 35; Sari, Goharbaran seashore, soil under eucalyptus, 36º73′12″ N, 53º11′14″ E, 5 m a.s.l., 12-May-2020, leg. E. Yahyapour, n= 6; Sari, Dashtenaz forest, 36°42'10"N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 6; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 6; Sari, rice field, 36°42'11"N, 53º10′12″ E, 11 m a.s.l., 12-May-2020, leg. E. Yahyapour, n= 56.

Entomobrya mesopotamica Rusek, 1981
General distribution: Iraq (Jordana & Baquero 2010).
Distribution in Iran: Kermanshah (Gahvareh, Sarabe-bid, Sorkh) and Markazi (Arak) provinces (Shoeibi et al., 2013; Kahrarian et al., 2014; Kahrarian, 2015).

Entomobrya multifasciata (Tullberg, 1871)
General distribution: Holarctic (Babenko et al., 2019).
Distribution in Iran: Golestan (Gorgan, Kordkuy), Kurdistan (Marivan-Garan, Marivan-Pirsafa), and Mazandaran (Babol, Galugah, Juybar, Qaemshahr, Sari) provinces (Yahyapour et al., 2011; Yoosefi Lafooraki, 2014; Darvish-Motevalli, 2016; Hosseini et al., 2016; Alijani-Ardeshir et al., 2017; Ghasemi Charati et al., 2022; Ahmadi et al., 2023).

Entomobrya muscorum (Nicolet, 1842)
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Kohgiluyeh and Boyer-Ahmad (Cheram) province (Falahati Hosseinabad et al., 2011).

Entomobrya nicoleti (Lubbock, 1868)
General distribution: Palaearctic (Fjellberg, 2007).
Distribution in Iran: Golestan (Gorgan, Kordkuy) province (Hosseini et al., 2016).

Entomobrya nigrocincta Denis, 1923
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Kermanshah (Char Zebar, Harasam, Qal'eh) and Mazandaran (Neka, Sari, Savadkooh) provinces (Kahrarian, 2015; Kahrarian et al., 2014; Yahyapour et al., 2018; Bakhshi et al., 2022; Zamani Khormandichali et al., 2024).
Examined material: Mazandaran province, Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 2; Sari, Goharbaran seashore, soil under eucalyptus, 36°42'12"N 53°11'14"E, 5 m a.s.l., 12-May-2020, leg. E. Yahyapour, n= 4.

Entomobrya nivalis (Linnaeus, 1758)
General distribution: Northern Holarctic (Babenko et al., 2019).
Distribution in Iran: Golestan (Gorgan, Kordkuy) province (Hosseini et al., 2016).

Entomobrya numidica Baquero, Hamra-Kroua & Jordana, 2009
General distribution: Algeria (Jordana, 2012).
Distribution in Iran: Golestan (Gorgan) province (Hosseini et al., 2016).

Entomobrya obscurella Brown, 1926
General distribution: Afghanistan, Palestine, Iraq (Jordana, 2012).

Distribution in Iran: Mazandaran (Sari, Savadkooh) province (Ghasemi Charati, 2017; Ghasemi Charati et al., 2022; Zamani Khormandichali et al., 2024).

Entomobrya quinquelineata Börner, 1901
General distribution: Europe (Jordana, 2012).
Distribution in Iran: Markazi (Arak) province (Shoeibi et al., 2013).

Entomobrya schoetti Stach, 1922
General distribution: Europe (Jordana, 2012).
Distribution in Iran: Guilan and Mazandaran (Neka) provinces (Kahrarian et al., 2014; Kahrarian, 2015;Yahyapour et al., 2018).

Entomobrya unostrigata Stach, 1930
General distribution: Mediterranean, Asia and possibily in USA (Jordana, 2012).
Distribution in Iran: Tehran province (Moravvej, 2003).

Genus *Mesentotoma* Salmon, 1942

Mesentotoma dollfussi (Denis, 1924)
General distribution: Europe, Algeria, Macaronesia (Jordana, 2012).
Distribution in Iran: Mazandaran (Qaemshahr) province (Darvish-Motevalli, 2016).

Mesentotoma subdollfusi Jacquemart, 1974
General distribution: Tunisia (Jordana, 2012).
Distribution in Iran: Golestan (Gorgan, Kordkouy), Guilan (Rasht), and Mazandaran (Qaemshahr, Savadkooh) provinces (Daghighi et al., 2013; Hosseini et al., 2016; Darvish-Motevalli, 2016; Zamani Khormandichali et al., 2024).

Genus *Prodrepanura* Stach, 1963

***Prodrepanura* sp.**
Distribution in Iran: Kermanshah province (Kahrarian et al., 2012).

Genus *Sinella* Brook, 1882

Sinella curviseta Brook, 1882
General distribution: Probably Holarctic (Jordana, 2012).
Distribution in Iran: Kerman (Shahdad), Mazandaran (Babol, Qaemshahr, Savadkooh), and Tehran provinces (Moravvej, 2003; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Darvish-Motevalli, 2016; Alijani-Ardeshir et al., 2017; Abdolalizadeh, 2018).

Subfamily Lepidocyrtinae Wahlgren, 1906
Genus *Lepidocyrtus* Bourlet, 1839

Lepidocyrtus bicoloris Mateos, 2012
General distribution: Spain (Mateos, 2012).
Distribution in Iran: Mazandaran (Neka) province (Bakhshi et al., 2022).
Examined material: Mazandaran province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1; Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 10; Sari, Abmal forest, 36º42′52″ N, 53º06′00″ E, 10 m a.s.l., 24-May-2020, leg. E. Yahyapour, n= 1.

Lepidocyrtus curvicollis Bourlet, 1839
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Kohgiluyeh and Boyer-Ahmad (Cheram) province (Falahati Hosseinabad et al., 2011).

Lepidocyrtus cyaneus Tullberg, 1871
General distribution: Cosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Central, East Azarbaijan, Golestan (Gorgan, Kordkuy), Guilan, Mazandaran, and Zanjan provinces (Cox, 1982; Hosseini et al., 2016).
Examined material: Mazandaran province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 4.

Lepidocyrtus lanuginosus (Gmelin, 1788)
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Central, East Azarbaijan, Golestan (Gorgan), Guilan, and Mazandaran (Neka) provinces (Cox, 1982; Hosseini et al., 2016; Bakhshi et al., 2022).
Examined material: Mazandaran province, Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1; Sari, Abmal forest, 36º42′52″ N, 53º06′00″ E, 10 m a.s.l., 24-May-2020, leg. E. Yahyapour, n= 2; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 1.

Lepidocyrtus lignorum (Fabricius, 1775)* (Figures 1A, B)
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: The species is reported for the first time from Iran.
Material examined: Mazandaran province, Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1.

Lepidocyrtus paradoxus Uzel, 1890
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Kohgiluyeh and Boyer-Ahmad (Cheram) province (Falahati Hosseinabad et al., 2011).

Lepidocyrtus ruber Schött, 1902
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Central, East Azarbaijan, Guilan, and Mazandaran provinces (Cox, 1982).

Genus *Pseudosinella* Schäffer, 1897

Pseudosinella alba (Packard, 1873)
General distribution: Cosmopolitan (Fjellberg, 2007).
Distribution in Iran: Guilan (Rasht) and Kurdistan (Marivan-Garan, Marivan-Pirsafa) provinces (Daghighi et al., 2013; Ahmadi et al., 2023).
Examined material: Mazandaran province, Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1.

Pseudosinella baghdadica Rusek, 1981
General distribution: Iraq (Rusek, 1981).
Distribution in Iran: Kermanshah (Derkah, Gerdeh Now, Harsin, Quri Qal'eh, Sahneh, Satar, Sonqor, Tamark) and Khuzestan (Shush) provinces (Yoosefi Lafooraki et al., 2014; Kahrarian, 2015; Kahrarian et al., 2014).

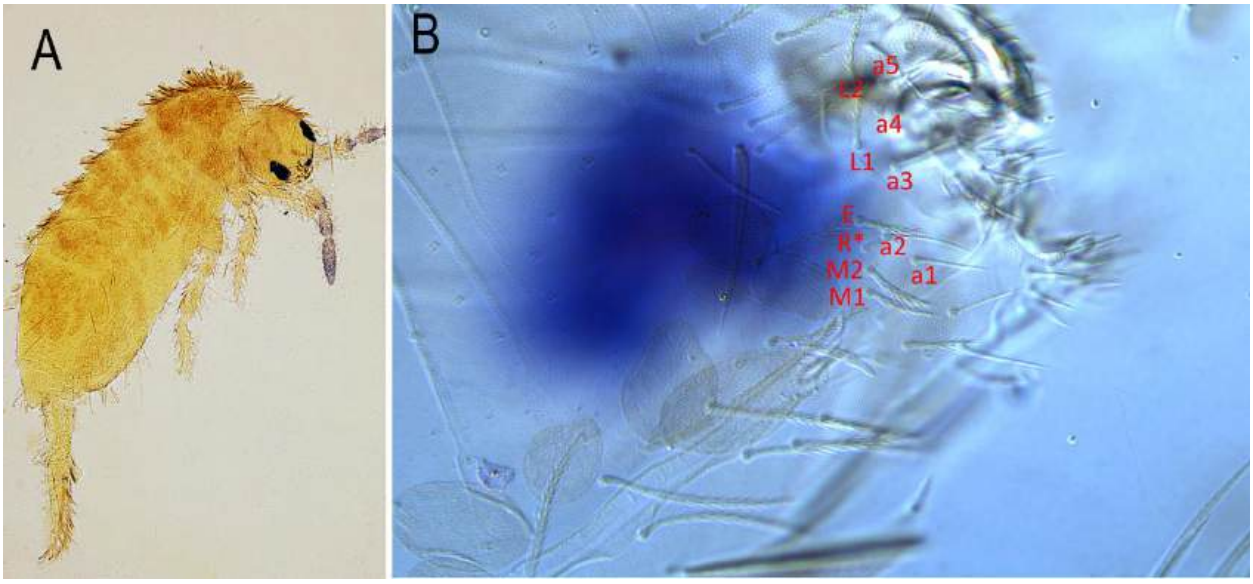

FIGURE 1. A) Habitus of *Lepidocyrtus lignorum* (Magnification 40X); B) Labium chaetotaxy of *Lepidocyrtus lignorum*; R* half in length than other setae (Magnification 100X)**.**

Pseudosinella* cf. *decipiens Denis, 1924
General distribution: Palaearctic (Fjellberg, 2007).
Distribution in Iran: Mazandaran (Sari) province (Shayanmehr et al., 2024).

Pseudosinella duodecimpunctata Denis, 1931
General distribution: Europe (Bellinger et al., 2024).
Distribution in Iran: East Azarbaijan province (Cox, 1982).

Pseudosinella immaculata (Lie Pettersen, 1896)
General distribution: Palaearctic (Fjellberg, 2007).
Distribution in Iran: Mazandaran (Sari) province (Shayanmehr et al., 2024).

Pseudosinella imparipunctata Gisin, 1953
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Guilan, Mazandaran, and Zanjan provinces (Cox, 1982).

Pseudosinella octopunctata Börner, 1901
General distribution: Cosmopolitan (Fjellberg, 2007).
Distribution in Iran: Central, East Azarbaijan, Golestan (Gorgan, Kordkuy), Guilan, Ilam, Isfahan (Zarrinshahr), Kerman (Shahdad), Kermanshah (Eslamabad-e-gharb, Gahvareh, Guilan-e-Gharb, Harsin, Javanrud, Kangavar, Kermanshah, Paveh, Qasr-e-shirin, Sahneh, Sar-e-pol-e- Zahab, Sonqor, Sonqor, Tazeh abad), Kohgiluyeh and Boyer-Ahmad, Kurdistan (Marivan-Garan, Marivan-Pirsafa), Lorestan, Markazi, Mazandaran (Babol, Babolsar, Behshahr, Larijan, Qaemshahr, Sari, Savadkooh), North Khorasan (Darkesh-Jozak forest, Golil-Sarany rangeland, Oghaz village), Tehran, West Azarbaijan, and Zanjan provinces (Cox, 1982; Yahyapour et al., 2011; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Qazi & Shayanmehr, 2014; Kahrarian et al. 2014; Balvasi et al., 2015; Kahrarian, 2015; Darvish-Motevalli, 2016; Hosseini et al., 2016; Alijani-Ardeshir et al., 2017; Abdolalizadeh, 2018; Ghasemi Charati, 2017; Moradi et al., 2018; Ghasemi Charati et al., 2022; Mehrafrooz Mayvan et al., 2022; Vahedi Moghadam et al., 2022; Ahmadi et al., 2023; Zamani Khormandichali et al., 2024).
Examined material: Mazandaran province, Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 9; Neka, Lemon village, Hezarjirib

forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 4; Sari, Goharbaran seashore, soil under eucalyptus, 36°42'12"N 53°11'14"E, 5 m a.s.l., 12-May-2020, leg. E. Yahyapour, n=1.

Pseudosinella sexoculata Schött, 1902
General distribution: Cosmopolitan (Fjellberg, 2007).
Distribution in Iran: Kermanshah and Kurdistan (Marivan-Garan, Marivan-Pirsafa) provinces (Ghahramaninezhad et al., 2013; Kahrarian, 2015; Ahmadi et al., 2023).

Subfamily Seirinae Yosii, 1961
Genus *Seira* Lubbock, 1870

Seira atlantica Negri, Pellecchia & Fanciulli, 2005
General distribution: Morocco (Negri et al., 2005).
Distribution in Iran: North Khorasan (Varaghi village) and Zanjan provinces (Shayanmehr et al., 2020a,b; Mehrafrooz Mayvan et al., 2022).

Seira domestica (Nicolet, 1842)
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Golestan (Gorgan, Kordkouy), Guilan (Rasht), Kermanshah (Harsin), and Mazandaran (Sari, Savadkooh, Qaemshahr) provinces (Yahyapour et al., 2011; Kahrarian et al., 2011; Daghighi et al., 2013; Darvish-Motevalli, 2016; Hosseini et al., 2016; Ghasemi Charati, 2017; Yahyapour et al., 2020; Ghasemi Charati et al., 2022; Zamani Khormandichali et al., 2024).
Examined material: Mazandaran province, Sari, Goharbaran seashore, soil under eucalyptus, 36°42'12"N 53°11'14"E, 5 m a.s.l., 12-May-2020, leg. E. Yahyapour, n= 16.

Seira dori Gruia, Poliakov & Broza, 2000
General distribution: Mediterranean (Gruia et al., 2000).
Distribution in Iran: Kurdistan (Marivan-Garan) province (Ahmadi et al., 2023).

Subfamily Willowsiinae Yoshii & Suhardjono, 1989
Genus *Drepanosira* Bonet, 1942

Drepanosira gisini Nosek, 1964
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: South Khorasan (Birjand) province (Rabieh et al., 2023).

Drepanosira hussi Neuherz 1976
General distribution: Paleotropical (Baquero et al., 2015).
Distribution in Iran: North Khorasan (Darkesh-Jozak forest) province (Mehrafrooz Mayvan et al., 2022).

Genus *Willowsia* Shoebotham, 1917

Willowsia bartkei Stach, 1965
General distribution: Vietnam (Zhang, 2015).
Distribution in Iran: North Khorasan (Darkesh-Jozak forest) province (Mehrafrooz Mayvan et al., 2022).

Willowsia buski (Lubbock, 1870)
General distribution: Cosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Kogiluyeh and Boyer-Ahmad (Cheram) province (Falahati Hosseinabad et al., 2011).

Willowsia nigromaculata (Lubbock, 1873)
General distribution: Holarctic (Babenko et al., 2019).
Distribution in Iran: Guilan (Rasht) province (Daghighi et al., 2013).

Family Orchesellidae Börner, 1906
Subfamily Heteromurinae Absolon & Kseneman, 1942
Genus *Heteromurtrella* Mari Mutt, 1979

***Heteromurtrella* sp.**
Distribution in Iran: North Khorasan (Golil-Sarany rangeland) province (Mehrafrooz Mayvan et al., 2022).

Genus *Heteromurus* Wankel, 1860

Heteromurus gigans Mari Mutt & Stomp, 1980
General distribution: Portugal (Arbea, 2021).
Distribution in Iran: Kurdistan (Marivan-Pirsafa) and Mazandaran (Babol, Sari) provinces (Ghasemi Cherati, 2017; Yahyapour et al., 2020; Ghasemi Charati et al., 2022; Ahmadi et al., 2023).

Heteromurus major (Moniez, 1889)
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Central, East Azarbaijan, Golestan (Gorgan), Guilan (Rasht), Kermanshah (Harsin, Kermanshah, Paveh), Kurdistan (Marivan-Garan, Marivan-Pirsafa), Lorestan, Mazandaran (Babol, Behshahr, Larijan, Neka, Noor, Qaemshahr, Sari, Savadkooh), and Tehran provinces (Cox, 1982; Yahyapour et al., 2011; Daghighi et al., 2013; Qazi & Shayanmehr, 2014; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Balvasi et al., 2015; Hosseini et al., 2016; Mehrafrooz Mayvan et al., 2015; Kahrarian et al., 2014, 2016; Darvish-Motevalli, 2016; Alijani-Ardeshir et al., 2017; Ghasemi Charati, 2017; Moradi et al., 2018; Bakhshi et al., 2022; Ghasemi Charati et al., 2022; Vahedi Moghadam et al., 2022; Ahmadi et al., 2023; Zamani Khormandichali et al., 2024).
Examined material: Mazandaran province, Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n>100; Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n>100; Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 39; Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 62; Sari, Marzrud village, 36º14′20″ N, 53º39′10″ E, 46 m a.s.l., 18-May-2020, leg. E. Yahyapour, n>100; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n>100; Sari, Abmal forest, 36º42′52″ N, 53º06′00″ E, 10 m a.s.l., 24-May-2020, leg. E. Yahyapour, n= 99; Sari, Dashtenaz forest, 36°42'10"N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 64.

Heteromurus nitidus (Templeton, 1836) in Templeton & Westwood 1836
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Golestan (Kordkouy), Guilan, Kermanshah (Harsin), Kohgiluyeh and Boyer-Ahmad, Mazandaran (Babol, Behshahr, Neka, Qaemshahr, Sari, Savadkooh), and North Khorasan (Darkesh-Jozak forest, Golil-Sarany rangeland, Mayvan village) provinces (Cox, 1982; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Hosseini et al., 2016; Kahrarian, 2015; Kahrarian et al., 2014, 2016; Darvish-Motevalli, 2016; Alijani-Ardeshir et al., 2017; Ghasemi Cherati,

2017; Bakhshi et al., 2022; Ghasemi Charati et al., 2022; Mehrafrooz Mayvan et al., 2022; Vahedi Moghadam et al., 2022; Zamani Khormandichali et al., 2024).
Examined material: Mazandaran province, Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 4; Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1; Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 2; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 9; Sari, Dashtenaz forest, 36°42'10"N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 1.

Heteromurus sexoculatus Brown, 1926
General distribution: Asia Minor (Dányi & Traser 2008).
Distribution in Iran: Mazandaran and Kermanshah (Char Zebar) provinces (Cox, 1982; Kahrarian et al., 2014; Kahrarian, 2015, 2019).

Heteromurus variabilis (Martynova, 1974) in Martynova et al. (1974)
General distribution: Tajikistan (Martynova et al., 1974).
Distribution in Iran: Kermanshah (Patagh, Sar-e-pole-Zahab), Mazandaran (Behshahr, Sari, Savadkooh) and North Khorasan (Darkesh-Jozak forest) provinces (Kahrarian, 2015; Kahrarian et al., 2015; Ghasemi Charati et al., 2022; Mehrafrooz Mayvan et al., 2022; Vahedi Moghadam et al., 2022; Zamani Khormandichali et al., 2024).

Subfamily Orchesellinae Börner, 1906
Genus *Orchesella* (Templeton, 1836) in Templeton & Westwood 1836

Orchesella cincta (Linnaeus, 1758)
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Golestan (Kordkuy) and Mazandaran (Babol, Behshar, Larijan, Neka, Sari, Savadkooh), North Khorasan (Darkesh-Jozak forest, Golil-Sarany rangeland) provinces (Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Balvasi et al., 2015; Hosseini et al., 2016; Yahyapour et al., 2018, 2020; Ghasemi Charati et al., 2022; Mehrafrooz Mayvan et al., 2022; Vahedi Moghadam et al., 2022).
Examined material: Mazandaran province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1; Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 14; Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 24; Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 14; Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1; Sari, Dashtenaz forest, 36°42'10" N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 1; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 5.

Orchesella flavescens (Bourlet, 1839)
General distribution: Holarctic (Fjellberg, 2007).
Distribution in Iran: North Khorasan (Golil-Sarany rangeland) province (Mehrafrooz Mayvan et al., 2022).

Orchesella spectabilis Tullberg, 1871
General distribution: Palaearctic (Fjellberg 2007).
Distribution in Iran: Mazandaran (Sari) province (Ghasemi Charati, 2017; Ghasemi Charati et al., 2022).

Family Paronellidae Börner, 1913
Subfamily Cyphoderinae Börner, 1913
Genus *Cyphoderus* Nicolet, 1842

Cyphoderus agnotus Börner, 1906
General distribution: Boreal and Neotropical (Lima & Zeppelini, 2021).
Distribution in Iran: Golestan (Gorgan, Kordkuy) province (Hosseini et al., 2016).

Cyphoderus albinus Nicolet, 1842
General distribution: Palaearctic (Fjellberg, 2007).
Distribution in Iran: Guilan (Rasht), Isfahan (Zarrinshahr), Kerman (Shahdad), Kermanshah (Parviz Khan, Qasr-e-shirin), Khuzestan, Kohgiluyeh and Boyer-Ahmad, Kurdistan (Marivan-Garan), Mazandaran (Babolsar, Qaemshahr), North Khorasan (Darkesh-Jozak forest), and Tehran provinces (Daghighi, 2012; Qazi & Shayanmehr, 2014; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Darvish-Motevalli, 2016; Kahrarian et al., 2016; Abdolalizadeh, 2018; Kahrarian, 2019; Mehrafrooz Mayvan et al., 2022; Ahmadi et al., 2023).

Cyphoderus bidenticulatus Parona, 1888
General distribution: Palaearctic (Thibaud 2017).
Distribution in Iran: Kermanshah (Harsin, Tamark) and Lorestan provinces (Kahrarian, 2015; Kahrarian et al., 2015; Ghavami, 2016).

Family Isotomidae Schäffer, 1896
Subfamily Anurophorinae Börner, 1901
Genus *Anurophorus* Nicolet, 1842

Anurophorus alpinus Potapov & Stebaeva, 1990
General distribution: Caucasus (Potapov, 2001).
Distribution in Iran: Mazandaran (Sari) province (Shayanmehr et al., 2024).

Anurophorus coiffaiti Cassagnau & Delamare, 1955
General distribution: Armenia, Lebanon, Syria (Potapov, 2001).
Distribution in Iran: Golestan (Gorgan), Guilan (Rasht), and Lorestan provinces (Daghighi, 2012; Falahati et al., 2013; Moradi et al., 2018).

Anurophorus septentrionalis Palissa, 1966
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Mazandaran (Amol, Nowshahr) province (Mohammadi Nodehaki & Shayanmehr, 2020).

Anurophorus silvaticus Potapov & Stebaeva, 1990
General distribution: Russia and Caucasus (Potapov, 2001).
Distribution in Iran: Mazandaran (Behshahr, Qaemshahr, Savadkooh) province (Yoosefi Lafooraki et al., 2019; Vahedi Moghadam et al., 2022).
Examined material: Mazandaran province, Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n=3.

Genus *Bagnallella* Salmon, 1951

Bagnallella tenella (Reuter, 1895)
General distribution: Cosmopolitan (Potapov et al., 2021).

Distribution in Iran: Guilan (Rasht) province (Daghighi, 2012; Daghighi et al., 2013).

Genus *Ballistura* Börner, 1906

Ballistura schoetti (Dalla Torre, 1895)
General distribution: Cosmopolitan (Potapov, 2001; Fjellberg, 2007).
Distribution in Iran: Guilan province (Cox, 1982).

Ballistura tuberculata (Stach, 1947)
General distribution: Central, Eastern Europe and N America (Potapov, 2001) and Iran
Distribution in Iran: Khuzestan province (Ramezani & Mossadegh, 2017).

Genus *Ephemerotoma* Potapov, Kahrarian, Deharveng & Shayanmehr, 2015

Ephemerotoma skarzynskii Potapov, Kahrarian, Deharveng & Shayanmehr, 2015
General distribution: Iran (Potapov et al., 2015).
Distribution in Iran: Kermanshah (Cheshmeh Sorkh, Osmanvand) province (Potapov et al., 2015).

Genus *Folsomia* Willem, 1902

Folsomia asiatica Martynova, 1971
General distribution: Tajikistan and Azerbaijan (Potapov, 2001).
Distribution in Iran: Golestan (Azadshahr, Kuhmian), Kermanshah (Paveh, Quri Qual'eh), and Lorestan provinces (Amiri & Kahrarian, 2015; Arbea & Kahrarian, 2015a; Ahmadi-Rad & Kahrarian, 2015; Yoosefi Lafooraki et al., 2020b).

Folsomia binoculata (Wahlgren, 1899)
General distribution: Palaearctic (Fjellberg, 2007).
Distribution in Iran: Kermanshah province (Ghahramaninezhad et al., 2013).

Folsomia brevifurca (Bagnall, 1949)
General distribution: Palaearctic (Dányi and Traser, 2008).
Distribution in Iran: Mazandaran province (Cox ,1982).

Folsomia candida (Willem, 1902)
General distribution: Cosmopolitan (Potapov, 2001; Fjellberg, 2007).
Distribution in Iran: Central, East Azarbaijan, Golestan (Aliabad, Azadshahr, Kuhmian), Guilan (Fuman, Rezwanshahr), Kurdistan (Marivan-Pirsafa), and Mazandaran (Abbas-Abad, Sari) provinces (Cox, 1982; Yahyapour, 2012; Yoosefi Lafooraki et al., 2020b; Ahmadi et al., 2023).

Folsomia diplophthalma (Axelson, 1902)
General distribution: Palaearctic (Babenko et al., 2019).
Distribution in Iran: Kerman (Mahan) province (Abdolalizadeh, 2018; Abdolalizadeh et al., 2018).

Folsomia fimetaria (Linnaeus, 1758)
General distribution: Holarctic (Babenko et al., 2019).
Distribution in Iran: Central, Guilan, and Mazandaran provinces (Cox, 1982).

Folsomia inoculata Stach, 1947
General distribution: Palaearctic (Bellinger et al., 2024).

Distribution in Iran: Mazandaran (Sari) province (Yahyapour et al., 2020).

Folsomia ksenemani Stach, 1947
General distribution: Europe, West Caucasus, Lebanon (Potapov, 2001).
Distribution in Iran: Mazandaran (Noor, Savadkooh) and Tehran provinces (Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Qazi and Shayanmehr, 2016).

Folsomia manolachei Bagnall, 1939
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Golestan (Gorgan), Kermanshah, Kurdistan (Marivan-Pirsafa), and Mazandaran (Behshahr) provinces (Arbea & Kahrarian, 2015b; Yoosefi Lafooraki et al., 2020b; Vahedi Moghadam et al., 2022; Ahmadi et al., 2023).
Examined material: Mazandaran province, Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 5; Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 7; Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 20.

Folsomia penicula Bagnall, 1939
General distribution: Holarctic (Bellinger et al., 2024).
Distribution in Iran: Central, Guilan (Astaneh-ashrafiyeh, Fuman, Rasht, Rezwanshahr, Rudbar, Shaft), Kermanshah, Kurdistan (Marivan-Pirsafa), Mazandaran (Abbas-Abad, Amol, Behshahr, Chalus, Galugah, Neka, Noor, Nowshahr, Qaemshahr, Sari, Savadkooh, Tonekabon), East Azarbaijan, Golestan (Aliabad, Bandar Gaz), North Khorasan (Darkesh-Jozak forest), and Tehran provinces (Cox, 1982; Falahati et al., 2011; Daghighi, 2012; Falahati et al., 2013; Daghighi et al., 2013; Qazi & Shayanmehr, 2014; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Arbea & Kahrarian, 2015; Yoosefi Lafooraki et al., 2020b; Bakhshi et al., 2022; Ghasemi Charati et al., 2022; Mehrafrooz Mayvan et al., 2022; Ahmadi et al., 2023; Zamani Khormandichali et al., 2024).
Examined material: Mazandaran Province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 7; Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 9; Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 21.

Folsomia quadrioculata (Tullberg, 1871)
General distribution: Subcosmopolitan (Checklist of the Collembola of the World 2024).
Distribution in Iran: Central, East Azarbaijan, Golestan (Bandar Gaz, Nowkandeh), Guilan (Shaft), Ilam (Choqa-Sabz Forest Park), Kermanshah (Char zabar, Shikh salaeh village, Ghap Gholi village, Sia Khor village), Kurdistan (Marivan-Pirsafa), Lorestan, Mazandaran (Abbas-Abad, Nowshahr), North Khorasan (Darkesh-Jozak forest, Golil-Sarany rangeland), and West Azarbaijan provinces (Cox, 1982; Amiri & Kahrarian, 2015; Arbea & Kahrarian, 2015a; Moradi et al., 2018; Shayanmehr et al., 2019; Yoosefi Lafooraki et al., 2020b; Mehrafrooz Mayvan et al., 2022; Ahmadi et al., 2023).

Folsomia similis Bagnall, 1939
General distribution: Holarctic (Babenko et al., 2019)
Distribution in Iran: Guilan (Rasht), Kermanshah (Paveh), and Tehran provinces (Moravvej et al., 2007; Daghighi, 2012; Amiri & Kahrarian, 2015; Arbea & Kahrarian, 2015a).

Folsomia trisetata Jordana & Ardanaz, 1981
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Mazandaran (Neka) province (Bakhshi et al., 2022).

Genus *Folsomides* Stach, 1922

Folsomides angularis (Axelson, 1905)
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Guilan (Rasht, Rudbar, Shaft) and Kurdistan (Marivan-Pirsafa) provinces (Daghighi et al., 2013; Yoosefi Lafooraki et al., 2020b; Ahmadi et al., 2023).

Folsomides halshinicus Arbea & Kahrarian, 2015
General distribution: Iran (Arbea & Kahrarian, 2015a).
Distribution in Iran: Kermanshah (Char zabar, Hassan Abad village, Islam Abad-e Gharb, Shabankareh village, Sia Khor village) and Kurdistan (Marivan-Pirsafa) provinces (Kahrarian, 2015; Ahmadi et al., 2023).

Folsomides marchicus (Frenzel, 1941)
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Ilam (Choqa-Sabz Forest Park, Dalab Forest Park, Gachan Mountains), Kermanshah (Eslamabade-Gharb), Kurdistan (Marivan-Garan, Marivan-Pirsafa), and Lorestan provinces (Kahrarian et al., 2012; Amiri & Kahrarian, 2015; Arbea & Kahrarian, 2015a; Kahrarian, 2015, 2019; Moradi et al., 2018; Shayanmehr et al., 2019; Ahmadi et al., 2023).

Folsomides parvulus (Starch, 1922)
General distribution: Cosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Central, East Azarbaijan, Golestan (Gonbade Qabus, Kordkuy, Minudasht), Guilan (Rasht), Kerman (Mahan), Kermanshah (Chahar Zebar-e-Oliya, Harsin), Kurdistan (Marivan-Garan), Lorestan, Mazandaran (Babol, Babolsar, Neka, Qaemshah, Sari, Savadkooh), North Khorasan (Golil-Sarany rangeland), Semnan (Mahdishahr), Tehran, and West Azarbaijan provinces (Cox, 1982; Yahyapour, 2012; Kahrarian et al., 2012; Daghighi, 2012; Daghighi et al., 2013; Qazi & Shayanmehr, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Amiri & Kahrarian, 2015; Kahrarian, 2015; Hosseini et al., 2016; Alijani-Ardeshir et al., 2017; Arbea & Kahrarian, 2017; Abdolalizadeh, 2018; Moradi et al., 2018; Yoosefi Lafooraki et al., 2020b; Bakhshi et al., 2022; Mehrafrooz Mayvan et al., 2022; Ahmadi et al., 2023; Zamani Khormandichali et al., 2024).
Examined material: Mazandaran province, Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1.

Folsomides subvinosus Arbea & Kahrarian, 2015
General distribution: Iran (Arbea and Kahrarian, 2015a,b).
Distribution in Iran: Kermanshah (Char zabar, Islam Abad-e Gharb, Shabankareh village, Sia Khor village) province (Arbea & Kahrarian, 2015; Kahrarian, 2015).

Genus *Gnathofolsomia* Deharveng & Christian, 1984

***Gnathofolsomia* sp.**
Distribution in Iran: Kermanshah province (Shayanmehr et al., 2019, 2020).

Genus *Hemisotoma* Bagnall, 1949

Hemisotoma orientalis (Stach, 1947)
General distribution: Ukraine, Kazakhstan, S Siberia, SE France (Potapov, 2001).

Distribution in Iran: Central, East Azarbaijan, Guilan, Kermanshah (Chahar Zebar-e-Oliya, Patagh), Mazandaran, and West Azarbaijan provinces (Cox, 1982; Amiri & Kahrarian, 2015; Arbea & Kahrarian, 2015a; Kahrarian, 2015).

Hemisotoma pontica Stach, 1947
General distribution: Palaearctic (Bellinger et al., 2024)
Distribution in Iran: Central, East Azarbaijan, Golestan (Aqqala, Bandar Torkmen), Guilan, Ilam (Arghavan Forest Park), Kermanshah, Kurdistan (Marivan-Garan, Marivan-Pirsafa), Lorestan, Mazandaran (Amol, Babol, Mahmood-abad, Qaemshahr, Sari, Simorq), North Khorasan (Darkesh-Jozak forest), Tehran, and West Azarbaijan provinces (
Cox, 1982; Moravvej et al., 2007; Kahrarian et al., 2012; Yahyapour, 2012; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Darvish-Motevalli, 2016; Alijani-Ardeshir et al., 2017; Moradi et al., 2018; Shayanmehr et al., 2019; Yoosefi Lafooraki et al., 2020b; Mehrafrooz Mayvan et al., 2022; Ahmadi et al., 2023).

Hemisotoma quadrioculata (Martynova, 1968): Martynova, 1968a
General distribution: Middle Asia, Tajikistan (Potapov, 2001).
Distribution in Iran: Ilam (Arghavan Forest Park) and Kurdistan (Marivan-Pirsafa) provinces (Shayanmehr et al., 2017; Ahmadi et al., 2023).

Hemisotoma thermophila (Axelson, 1900)
General distribution: Cosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Central, East Azarbaijan, Golestan (Aqqala, Azadshahr, Galikesh, Gorgan, Kordkuy, Maraveh Tappeh, Minudasht), Guilan (Rasht, Masal), Kermanshah (Derkah village, Shikh salaeh village, Rijab), Mazandaran (Amol, Larijan, Mahmood-abad, Noor,), and West Azarbaijan provinces (Cox, 1982; Daghighi, 2012; Daghighi et al., 2013; Yoosefi Lafooraki (2014), Yoosefi Lafooraki & Shayanmehr, 2014a; Balvasi et al., 2015; Arbea & Kahrarian, 2015a; Yoosefi Lafooraki et al., 2020b).
Examined material: Mazandaran province, Sari, Goharbaran seashore, soil under eucalyptus, 36°42'12" N 53°11'14" E, 5 m a.s.l., 12-May-2020, leg. E. Yahyapour, n= 1.

Genus *Isotomiella* Bagnall, 1939

Isotomiella gracilimucronata Rusek, 1981
General distribution: Iraq (Potapov, 2001).
Distribution in Iran: North Khorasan (Golil-Sarany rangeland) province (Mehrafrooz Mayvan et al., 2022).

Isotomiella minor (Schäffer, 1896)
General distribution: Cosmopolitan (Bellinger et al., 2024).
Distribution in Iran: East Azarbaijan, Golestan (Ali-abad, Bandar Gaz, Gorgan, Kordkuy, Ramian), Guilan (Fuman, Lahijan, Rasht, Rudsar, Talesh), Kerman (Koohpayeh village), Kermanshah (Shabankareh village, Patagh), Kurdistan (Marivan-Garan), Lorestan, Mazandaran (Abbas-Abad, Amol, Behshahr, Qaemshahr, Neka, Noor, Nowshahr, Sari, Savadkooh), North Khorasan (Golil-Sarany rangeland), and Tehran provinces (Cox, 1982; Moravvej et al., 2007; Yahyapour, 2012; Daghighi, 2012; Ghahramaninezhad et al., 2013; Daghighi et al., 2013; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Amiri & Kahrarian, 2015; Arbea & Kahrarian 2015a; Kahrarian, 2015, 2019; Hosseini et al., 2016; Ghasemi Charati, 2017; Abdolalizadeh, 2018; Moradi et al., 2018; Yoosefi Lafooraki et al., 2020b; Bakhshi et al., 2022; Ghasemi Charati et al., 2022; Mehrafrooz Mayvan et al., 2022; Ahmadi et al., 2023; Zamani Khormandichali et al., 2024).

Examined material: Mazandaran Province, Sari, Dashtenaz forest, 36°42'10" N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 1.

Genus *Proisotoma* Börner, 1903

Proisotoma minima Absolon, 1901
General distribution: Holarctic with some records from the southern hemisphere (Babenko et al. 2019).
Distribution in Iran: Golestan (Golestan National Park) and Mazandaran (Sari) provinces (Yoosefi Lafooraki & Shayanmehr, 2014; Yahyapour et al., 2020).

Proisotoma minuta (Tullberg, 1871)
General distribution: Cosmopolitan (Babenko et al., 2019).
Distribution in Iran: Central, East Azarbaijan, Golestan (Kordkuy, Palangpa forest), Guilan (Parehsar, Rasht, Rezwanshahr, Rudbar), Isfahan, Mazandaran (Chalus, Larijan, Mahmood-abad), and West Azarbaijan provinces (Cox, 1982; Nematollahi et al., 2009; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Balvasi et al., 2015; Hosseini et al., 2016; Yoosefi Lafooraki et al., 2020b).

Proisotoma subminuta Denis, 1931
General distribution: Cosmopolitan (Fjellberg, 2007).
Distribution in Iran: Golestan, Guilan (Rasht), Mazandaran (Amol), and Tehran provinces (Moravvej et al., 2007; Daghighi, 2012; Daghighi et al., 2013; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014.; Yoosefi Lafooraki et al., 2020b).

Genus *Subisotoma* (Stach, 1947)

Subisotoma variabilis (Gisin, 1949)
General distribution: Switzerland, Austria, Poland, Slovakia, France, Iberian Peninsula, Siberia, Kazakhstan, and Central Asia (Potapov, 2001).
Distribution in Iran: Kermanshah (Patagh, Sar-e-pole-Zahab) province (Kahrarian, 2015; Kahrarian et al., 2015).

Subfamily Isotominae Schäffer, 1896
Genus *Agrenia* Börner, 1906

***Agrenia* sp.**
Distribution in Iran: North Khorasan (Zoeram village) province (Mehrafrooz Mayvan et al., 2022).

Genus *Desoria* Agassiz & Nicolet, 1841 in Desor (1841)

Desoria neglecta (Schäffer, 1900)
General distribution: Holarctic (Fjellberg, 2007).
Distribution in Iran: Kurdistan (Marivan-Pirsafa), Lorestan, and Mazandaran (Savadkooh) provinces (Moradi et al., 2018; Ahmadi et al., 2023; Zamani Khormandichali et al., 2024).

Desoria kaszabi Dunger, 1982*
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: This species is recorded for the first time from Iran.
Examined material: Mazandaran province, Sari, Marzrud village, 36º14′20″ N, 53º39′10″ E, 46 m a.s.l., 18-May-2020, leg. E. Yahyapour, n=47; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l.,

20-May-2020, leg. E. Yahyapour, n= 4; Sari, Dashtenaz forest, 36°42'10" N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 2.

Desoria olivacea (Tullberg, 1871)
General distribution: Holarctic (Fjellberg, 2007).
Distribution in Iran: East Azarbaijan province (Cox, 1982).

Desoria tigrina Nicolet, 1842
General distribution: Palaearctic (Fjellberg, 2007).
Distribution in Iran: Kermanshah (Derkah) and Lorestan provinces (Kahrarian et al., 2012; Kahrarian, 2015; Kahrarian & Arbea, 2015; Arbea & Kahrarian, 2015a; Kahrarian, 2019; Moradi et al., 2018).

Desoria trispinata (MacGillivray, 1896)
General distribution: Cosmopolitan (Babenko et al., 2019).
Distribution in Iran: North Khorasan (Darkesh-Jozak forest) province (Mehrafrooz Mayvan et al., 2022).

Desoria zlotini Martynova, 1968: Martynova, 1968b
General distribution: Kirghisia, Tajikistan, Mongolia (Potapov, 2001).
Distribution in Iran: Kermanshah (Osmanevad, Sragool village) province (Amiri & Kahrarian, 2015; Kahrarian et al., 2015).

Genus *Isotoma* Bourlet, 1839

Isotoma anglicana Lubbock, 1862
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Ilam (Arghavan Forest Park, Dalab Forest Park, Gachan Mountain) province (Shaynmehr et al., 2017).
Additional localities: Mazandaran province, Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 2; Sari, Dashtenaz forest, 36°42'10" N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 2.

Isotoma iranica Arbea & Kahrarian, 2015
General distribution: Iran (Arbea and Kahrarian, 2015b).
Distribution in Iran: Golestan (Galikesh, Minudasht, Ramian), Kermanshah (Paveh, Shahu city), Lorestan, and Mazandaran (Savadkooh) provinces (Arbea & Kahrarian, 2015a; Moradi et al., 2018; Yoosefi Lafooraki et al., 2020b; Zamani Khormandichali et al., 2024).
Additional localities: Mazandaran province, Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 1.

Isotoma* cf. *riparia (Nicolet, 1842)
General distribution: Palaearctic (Fjellberg, 2007).
Distribution in Iran: Mazandaran (Babol) province (Alijani-Ardeshir et al., 2017).

Isotoma viridis Bourlet, 1839
General distribution: Holarctic (Babenko et al., 2019).
Distribution in Iran: Central, East Azarbaijan, Golestan (Golestan National Park), Kermanshah (Paveh, Shabankareh), Kurdistan (Marivan-Garan, Marivan-Pirsafa), Mazandaran (Babol, Sari), North Khorasan (Darkesh-Jozak forest), and West Azarbaijan provinces (Cox, 1982; Yahyapour, 2012; Amiri & Kahrarian, 2015; Kahrarian, 2015, 2019; Alijani-Ardeshir et al., 2017; Mehrafrooz Mayvan et al., 2022; Ahmadi at al., 2023).

Genus *Isotomodella* Martynova, 1968

Isotomodella alticola (Bagnall, 1949)
General distribution: Palaearctic (Fjellberg, 2007).
Distribution in Iran: Lorestan (Khoram-Abad, Veysian, Delbar Sadat village) province (Shayanmehr et al., 2018).

Genus *Isotomodes* Axelson, 1907

Isotomodes golestani Yoosefi Lafooraki, Hajizadeh, Shayanmehr & Hosseini, 2020
General distribution: Iran (Yoosefi Lafooraki et al., 2020b).
Distribution in Iran: Golestan (Gonbade Qabus) province (Yoosefi Lafooraki et al., 2020b).

Isotomodes korkorensis Arbea & Kahrarian, 2015
General distribution: Iran (Arbea & Kahrarian, 2015b).
Distribution in Iran: Kermanshah (Char zabar, Kor Kor Mountain) province (Arbea & Kahrarian, 2015a).

Genus *Isotomurus* Börner, 1903

Isotomurus afghanicus Yosii, 1966
General distribution: Iran and Afghanistan (Yoosefi Lafooraki et al., 2023).
Distribution in Iran: Mazandaran (Amol, Mahmood-Abad, Neka, Noor, Nowshahr, Sari) province (Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Bakhshi et al., 2022; Yoosefi Lafooraki et al., 2023).
Additional localities: Mazandaran province, Sari, Marzrud village, 36º14′20″ N, 53º39′10″ E, 46 m a.s.l., 18-May-2020, leg. E. Yahyapour, n= 76; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 14; Sari, Abmal forest, 36º42′52″ N, 53º06′00″ E, 10 m a.s.l., 24-May-2020, leg. E. Yahyapour, n= 13; Sari, Dashtenaz forest, 36°42'10" N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 6.

Isotomurus antennalis Bagnall, 1940
General distribution: Palaearctic (Potapov, 2001).
Distribution in Iran: Mazandaran (Babol) province (Alijani-Ardeshir et al., 2017).

Isotomurus* cf. *balteatus (Reuter, 1876)
General distribution: Unclear (revision needed) (Fjellberg, 2007).
Distribution in Iran: Golestan (Kordkuy) province (Hosseini et al., 2016).

Isotomurus cassagnaui Deharveg & Lek, 1993
General distribution: France (Thibaud, 2017).
Distribution in Iran: Mazandaran (Sari) province (Zamani, 2016).

Isotomurus fucicola (Schött, 1893)
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Mazandaran (Qaemshahr) province (Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014).
Additional localities: Mazandaran province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 3; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 1.

Isotomurus graminis Fjellberg, 2007
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: North Khorasan (Golil-Sarany rangeland) province (Mehrafrooz Mayvan & Greenslade, 2020; Mehrafrooz Mayvan et al., 2022).

Isotomurus hyrcanicus Yoosefi Lafooraki & Shayanmehr, 2023 in Yoosefi Lafooraki et al. (2023)
General distribution: Iran (Yoosefi Lafooraki et al., 2023).
Distribution in Iran: Golestan (Bandar Gaz, Bandar Torkaman) and Mazandaran (Sari, Savadkooh) provinces (Yoosefi Lafooraki et al., 2023; Zamani Khormandichali et al., 2024).

Isotomurus katule Yoosefi Lafooraki & Shayanmehr, 2023 in Yoosefi Lafooraki et al. (2023)
General distribution: Iran (Yoosefi Lafooraki et al., 2023).
Distribution in Iran: Golestan (Aliabad-e katul) and Mazandaran (Savadkooh) provinces (Yoosefi Lafooraki et al., 2023; Zamani Khormandichali et al., 2024).

Isotomurus maculatus (Schäffer, 1896)
General distribution: unclear (revision needed) (Fjellberg, 2007).
Distribution in Iran: Golestan (Gorgan) and Mazandaran (Sari) provinces (Falahati et al., 2011, 2013; Yoosefi Lafooraki et al., 2023).

Isotomurus matanicus Shayanmehr, Yoosefi & Zamani, 2024 in Zamani Khormandichali et al. 2024
General distribution: Iran (Zamani Khormandichali et al., 2024).
Distribution in Iran: Mazandaran (Savadkooh) province (Zamani Khormandichali et al., 2024).

Isotomurus palustris (Müller, 1776)
General distribution: Cosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Central, Golestan (Kordkuy, Palangpa forest, Imam Reza forest), Guilan, Khuzestan, and Mazandaran (Sari) provinces (Cox, 1982; Hosseini et al., 2016; Zamani, 2016; Ramezani & Mossadegh, 2017).
Additional localities: Mazandaran province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 2; Sari, Marzrud village, 36º14′20″ N, 53º39′10″ E, 46 m a.s.l., 18-May-2020, leg. E. Yahyapour, n= 2; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 1.

Isotomurus potapovi Yoosefi Lafooraki & Shayanmehr, 2023 in Yoosefi Lafooraki et al. (2023)
General distribution: Iran (Yoosefi Lafooraki et al., 2023).
Distribution in Iran: Golestan (Bandar Gaz, Kordkuy), Guilan (Amlash, Falakdeh, Ostad–Kalayeh, Rasht, Roodbar), and Mazandaran (Abbas-Abad, Savadkooh, Tonekabon) provinces (Yoosefi Lafooraki et al., 2023; Zamani Khormandichali et al., 2024).

Isotomurus punctiferus Yosii, 1963
General distribution: Palaearctic (Bellinger et al., 2024).
Distribution in Iran: Golestan (Gorgan) and Guilan (Rasht) provinces (Falahati et al., 2013; Daghighi et al., 2013; Yoosefi Lafooraki et al., 2023).
Additional localities: Mazandaran province, Sari, rice field, 36°42'10" N, 53º10′12″ E, 11 m a.s.l., 12-May-2020, leg. E. Yahyapour, n= 30.

Isotomurus stuxbergi (Tullberg, 1876)
General distribution: Holoarctic (Babenko et al., 2019).
Distribution in Iran: Mazandaran (Qaemshahr) province (Darvish-Motevalli, 2016).

Genus *Pachyotoma* Bagnall, 1949

***Pachyotoma* sp.**
Distribution in Iran: Kermanshah province (Amiri & Kahrarian, 2015).

Genus *Parisotoma* Bagnall, 1940

Parisotoma notabilis (Schäffer, 1896)
General distribution: Cosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Central, East Azarbaijan, Golestan (Aliabd, Bandar Gaz, Bandar Torkmen, Golestan National Park, Kalaleh, Kordkuy, Maraveh Tappe, Palangpa forest), Guilan (Astaneh-ashrafiyeh, Fuman, Langrud, Rasht, Rezwanshahr, Rudbar, Rudsar, Shaft, Somesara, Talesh), Kerman (Mahan, Shahdad), Kermanshah (Patagh, Shabankareh villag), Kermanshah, Khuzestan, Kurdistan (Marivan-Garan, Marivan-Pirsafa), Lorestan, Mazandaran (Behshahr, Chalus, Galugah, Qaemshahr, Kodirsar, Mahmood-Abad, Neka, Noor, Nowshahr, Royan, Savadkooh), North Khorasan (Darkesh-Jozak forest, Gelyan village, Golil-Sarany rangeland), Tehran, West Azarbaijan, and Zanjan provinces (Cox, 1982; Moravvej et al., 2007; Kahrarian et al., 2012; Daghighi et al., 2013; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Amiri & Kahrarian, 2015; Arbea & Kahrarian, 2015a; Kahrarian, 2015, 2019; Hosseini et al., 2016; Ramezani & Mossadegh, 2017; Abdolalizadeh, 2018; Moradi et al., 2018; Yoosefi Lafooraki et al., 2020; Bakhshi et al., 2022; Mehrafrooz Mayvan et al., 2022; Ahmadi et al., 2023; Zamani Khormandichali et al., 2024).
Additional localities: Mazandaran province, Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 3; Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 46; Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 16; Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 15; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 56; Sari, Abmal forest, 36º42′52″ N, 53º06′00″ E, 10 m a.s.l., 24-May-2020, leg. E. Yahyapour, n= 3; Sari, Dashtenaz forest, 36°42'10" N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 13.

Genus *Pseudisotoma* Handschin, 1924

Pseudisotoma sensibilis (Tullberg, 1876)
General distribution: Palaearctic (Fjellberg, 2007).
Distribution in Iran: Kurdistan (Marivan-Garan, Marivan-Pirsafa) and Mazandaran (Noor, Royan) provinces (Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayannmehr, 2014; Ahmadi et al., 2023).

Genus *Vertagopus* Börner, 1906

Vertagopus persicus Potapov, Yoosefi & Shayanmehr, 2020 in Yoosefi Lafooraki et al. 2020a
General distribution: West Asia (Bellinger et al., 2024).
Distribution in Iran: Golestan (Nokandeh), Guilan (Shaft), and Mazandaran (Abbas-Abad) provinces (Yoosefi Lafooraki et al., 2020a).
Additional localities: Mazandaran Province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 24; Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 2; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 10.

Family Oncopoduridae Carl & Lebedinsky, 1905
Genus *Oncopodura* Carl & Lebedinsky, 1905

Oncopodura ambigua Christiansen, 1957
General distribution: Lebanon (Christiansen, 1957).
Distribution in Iran: Guilan and Mazandaran provinces (Cox, 1982).

Oncopodura hamata Carl & Lebedinsky, 1905
General distribution: Europe (Arbea, 2021).
Distribution in Iran: Guilan province (Daghighi, 2012).

Family Tomoceridae Schäffer, 1896
Genus *Pogonognathellus* Paclt, 1944

Pogonognathellus flavescens (Tullberg, 1871) (Figure 2)
General distribution: Palaearctic and Nearctic (Babenko et al., 2019).
Distribution in Iran: Mazandaran (Babol, Neka, Sari, Tonekabon) province (Yahyapour et al., 2018).

Genus *Tomocerina* Yosii, 1955

Tomocerina minuta (Tullberg, 1876) (Figure 3B)
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Mazandaran (Neka, Sari) province (Yahyapour et al., 2021; Bakhshi et al., 2022).
Examined material: Mazandaran province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 8; Behshahr, Zenget village, Hezarjirib forest, 36º25′15″ N, 53º34′16″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1; Neka, Lemon village, Hezarjirib forest, 36º27′18″ N, 53º34′04″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 10; Neka, Sapelmiun village, 36º23′11″ N, 53º34′18″ E, 1057 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 8; Sari, Dashtenaz forest, 36°42'10" N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 60; Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 17.

Genus *Tomocerus* Nicolet, 1842

Tomocerus asiaticus Martynova 1969*
General distribution: West and Central Asia (Bellinger et al., 2024).
Distribution in Iran: The species is reported for the first time from Iran.
Additional localities: Mazandaran province, Sari, Zarrin-Abad forest, 36º32′44″ N, 53º07′53″ E, 113 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 1; Sari, Dashtenaz forest, 36°42'10" N, 53º9′11″ E, 11 m a.s.l., 20-May-2020, leg. E. Yahyapour, n= 1.

Tomocerus minor (Lubbock, 1862) (Figure 4A)
General distribution: Subcosmopolitan (Bellinger et al., 2024).
Distribution in Iran: Central, East Azarbaijan, Golestan, Guilan, Kerman, Mazandaran, and Zanjan provinces (Cox, 1982; Hosseini et al., 2016; Abdolalizadeh, 2018).
Examined material: Mazandaran province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 4.

FIGURE 2. Inner side of dens with a broad pointed scale near base base in *Pogonognathellus flavescens* (Yahyapour et al., 2018)**.**

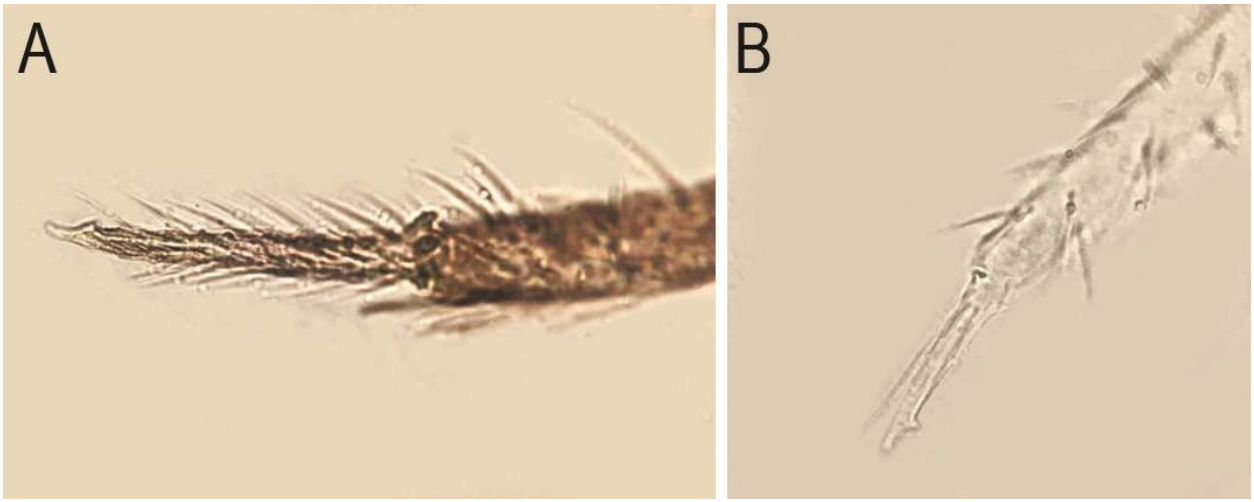

FIGURE 3. A) Mucro with two dorsal lamella, mid-section of mucro with more than three teeth in *Tomocerus vulgaris*, B) Mid-section of mucro at most with three teeth in *Tomocerina minuta* (Magnification 40X).

Tomocerus vulgaris (Tullberg, 1871) (Figure 3B, 4B)

General distribution: Subcosmopolitan (Bellinger et al., 2024).

Distribution in Iran: Central, East Azarbaijan, Golestan, Guilan, Kermanshah, Mazandaran (Behshahr, Sari, Tonekabon), North Khorasan (Darkesh-Jozak forest), and Zanjan provinces (Cox, 1982; Yoosefi Lafooraki, 2014; Yoosefi Lafooraki & Shayanmehr, 2014; Balvasi et al., 2015; Kahrarian, 2015; Kahrarian et al., 2014, 2015; Hosseini et al., 2016; Alijani-Ardeshir et al., 2017; Yahyapour et al., 2020; Ghasemi Charati et al., 2022; Mehrafrooz Mayvan et al., 2022; Vahedi Moghadam et al., 2022).

Examined material: Mazandaran Province, Behshahr, Rudbar village, Hezarjirib forest, 36º27′18″ N, 53º34′47″ E, 46 m a.s.l., 10-May-2020, leg. E. Yahyapour, n= 1; Sari, Abmal forest, 36º42′52″ N, 53º06′00″ E, 10 m a.s.l., 24-May-2020, leg. E. Yahyapour, n= 1.

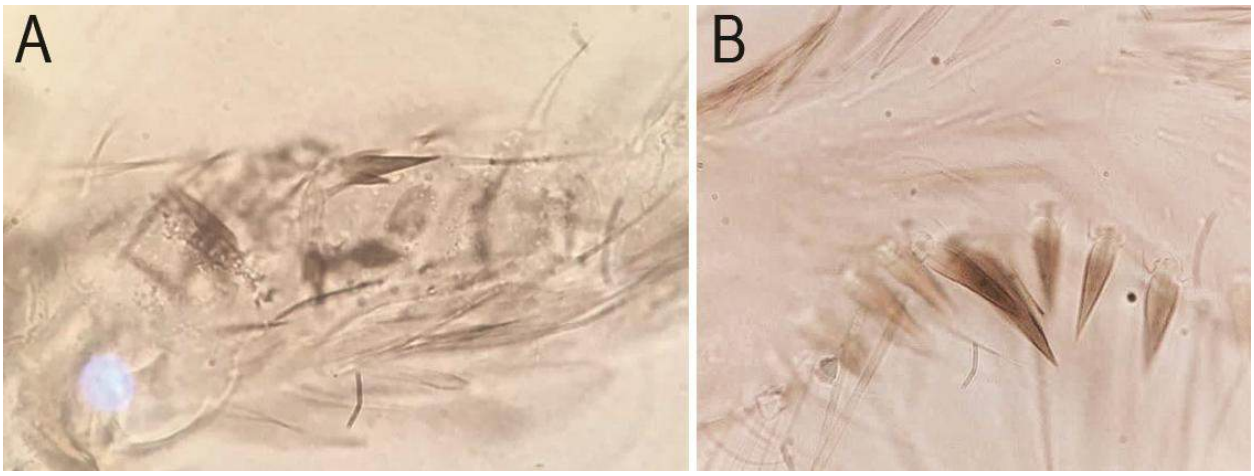

FIGURE 4. A) Dorsal spines of dens 3-forked in *Tomocerus minor*, B) Simple spines on dorsal side of dens in *Tomocerus vulgaris* (Magnification 100X).

Key to species of Tomoceridae family in Iran (according to Fjellberg, 2007):

1- Inner side of dens with a broad pointed scale near base (Fig. 3). Basolateral field of labium with more than five setae. Mucro with one dorsal lamella ……. ……***….ogonognathellus flavescens*** (Tullberg, 1871)
- Inner side of dens without broad scale. Basolateral field of labium with 5 setae. Mucro with two dorsal lamella (Fig. 4), the outer one with small teeth ……..……. 2
2- All tibiotarsi with several differentiated macrochaetae on inner side. Mid-section of mucro with more than 3 teeth (Fig. 4), outer basal tooth with a small secondary tooth ….***Tomocerus*** Nicolet 3
- Tibiotarsi 1-2 without, tib. 3 with one inner macrochaetae. Mid-section of mucro at most with 3 teeth (Fig. 5), outer basal tooth simple ……..…… ***Tomocerina minuta*** (Tullberg, 1876)
3- Dorsal spines of dens 3-forked (Fig. 6) ……..... ***Tomocerus minor***
- Dorsal spines of dens simple (Fig. 7) …….. 4
4- Empodium without teeth ……..… ***Tomocerus asiaticus***
- Empodium with one inner tooth …….....…… ***Tomocerus vulgaris***

DISCUSSION

Our comprehensive study documents 139 species from 41 genera across six families of Entomobryomorpha in Iran, including three newly reported species. The family-level diversity shows Isotomidae as the most speciose (69 species, 21 genera), followed by Entomobryidae (51 species, 12 genera), Orchesellidae (9 species, 3 genera), Tomoceridae (5 species, 3 genera), Paronellidae (3 species, 1 genus), and Oncopoduridae (2 species, 1 genus). A particularly noteworthy finding emerges when comparing our results with the previous checklist by Shayanmehr et al. (2020). In just five years, we've witnessed remarkable growth in documented Entomobryomorpha diversity: from 34 to 105 species (309% increase) in the Isotomidae family, from 34 total species reported in 2020 to 139 species currently known, 2.9-fold increase in recorded species richness, and 15 new genera added to Iran's fauna. This dramatic expansion can be attributed to intensive sampling in previously unexplored regions and re-examination of historical collections

The rapid discovery rate suggests Iran likely represents a biodiversity hotspot for Collembola and many species remain to be discovered. Therefore we recommend targeted sampling in understudied ecoregions and development of regional identification keys. This study establishes a new baseline for understanding Collembola diversity in Western Asia and highlights the importance of sustained taxonomic research on microarthropods.

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RESEARCH ARTICLE Open access

A study of Coccinellid species with a focus on those associated with *Pistacia* spp. (Anacardiacae) in western part of Iran

Abedin Safari[1], Hassan-Ali Vahedi[1]*, Hadis Nehrangi[1], Mohamad Roshan-Heidari[2], Amir Biranvand[3], Oldřich Nedvěd[4,5] and Seyed Massoud Madjdzadeh[6]

[1] *Department of Plant Protection, Campus of Agriculture and Natural Resources, Razi University, Kermanshah, Iran.*
[2] *Department of Agriculture, Imperial College, University of London, London, UK.*
[3] *Young Researchers and Elite Club, Khorramabad Branch, Islamic Azad University, Khorramabad, Iran.*
[4] *Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic.*
[5] *Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic.*
[6] *Department of Biology, Faculty of Sciences, Shahid Bahonar University of Kerman, Kerman, Iran.*

Abstract
The coccinellid fauna in Kermanshah province, were studied between 2020 and 2023. More than 4418 individuals were collected from different plants and ecosystems. Consequently, a total of 26 species were identified, half of them were recorded on both cultivated and wild pistachios, which mainly infested by Sternorrhyncha suborder. The identified species belonged to five tribes: Chilocorini (five species, three genera), Coccinellini (11 species, seven genera), Hyperaspidini (one species, one genus), Scymnini (eight species, four genera), Sticholotidini (one species, one genus). Among the 26 species identified, ten were recognized as new records for the Kermanshah region, indicated with a single star*.Thirteen species associated with pistachio trees in the same area were marked with two stars**. Data about collection of each species including prey species and host plants are presented with synonyms, previous records, present records, distribution, and remarks. Color plates of adult specimens and genitalia are given.

Key words: Faunistic, Predator, Anacardiacae, Checklist, Distribution.

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INTRODUCTION

Coccinellidae is a family of beetles with a global distribution, including more than 6000 species, classified in 370 genera (Ślipiński 2007). Iranian coccinellid fauna includes 17 tribes, 41 genera and 142 species (Abdolahi Mesbah et al., 2016). In the coccinellid fauna of Iran, there are 25 species that are linked to pistachio trees, in Kerman province (Salehi et al., 2011). In the above-mentioned publication, only 24 species were reported from Kermanshah province. In general, the fauna of ladybugs, particularly those associated with pistachio trees, is still poorly known in Kermanshah province.

Majority of coccinellids or ladybirds are entomophagous and many are used as a biological control agent against economically important pests. Those are associated with Sternorrhyncha (Aphidoidea, Coccoidea, Aleyrodoidea, Psylloidea, Cicadelloidea) and others, such as, Lepidoptera larvae and mites.

To reduce the overuse of chemical substances (or chemical control) for managing pistachio pests, it is necessary to conduct research aimed at identifying the predatory ladybird species present in the study area, particularly those species associated with pistachio pests. Regarding the rare studies on ladybirds

*Corresponding Author: ✉ : vnassah@yahoo.com

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within pistachio orchards, it is expected that certain species will be discovered that play a significant role in the biological control of these pests.

This study was conducted to record ladybird species, particularly those associated with pistachio trees in Kermanshah province, which will be of value to ecology, biology, systematics and other trends in agricultural and biological sciences. The aim of this article is to present the first overview of the coccinellid fauna including their prey species, distribution, and host plants in Western Iran.

MATERIAL AND METHODS

Ladybird samples on various infested host plants, including Pistachio trees, were collected during irregular surveys in different locations in Kermanshah region between 2020 and 2023. Sampling was done using direct sampling, insect nets, a beating white tray and the samples were collected manually or with a brush. In each sample, coccinellids were separated and placed in a jar with etylacetate, after which they were transferred to labeled 96% alcohol containers. Microscopic slides with male genitalia were prepared using Canada balsam medium by the methodology of Slipinski and Tomaszewska (2005). Images were taken using the Blue Light model of the Eyepist (Scaled Loop) and SSC-DC50AP digital camera, model XTS3022, and Olympus BX microscope with an attached digital Dino eye-piece camera. For identification of specimens, we used the following literature: Raimundo and van Harten, (2000); Larson (2013); Bieńkowski (2018); Biranvand et al. (2019). Identification of selected specimens were confirmed by Dr. Amir Biranvand and Professor Oldřich Nedvěd. The slide-mounted material of all species has been deposited in the Department of Plant Protection, Razi University, Kermanshah, Iran. Iranian coccinellid literature review was made. The nomenclature is based on classification of Coccinellidae by Kovář (2007) and Nedvěd (2020).

RESULTS

A total of 26 species of coccinellids in 16 genera and 5 tribes including 4418 individuals were collected on 37 plant species, including *Pistacia vera* Linnaeus and *P. mutica* (Fisch. & C.A. Mey.), in Kermanshah. Half of these species (13) were collected on both cultivated pistachio and mountain pistachios. Both tree mainly infested by Sternorrhyncha group. Also, among these species, the lady beetle *Coccinella septempunctata* L.,1758 on *Medicago sativa*, *Hippodamia variegata* (Goeze, 1777) on *Carthamus* sp. and *Oenopia conglobata* (Linnaeus, 1758) on *Prunus persica* all occur in large numbers throughout the region and are likely to be biologically important.

Species accounts
Tribe CHILOCORINI
Genus *Chilocorus* Leach, 1815

***Chilocorus bipustulatus* (Linnaeus, 1758)**
(Figures 1, 27A)

Syn.: *Coccinella bipustulata* Linnaeus, 1758

Notes: *Chilocorus bipustulatus* (Figs. 1, 27A) was collected directly by hand and beating tray. The host plants were infested by Aphidoidea. Previously, this species has been reported by Khosravi *et al.* (2014), on *Trabutina mannipara* (Hemprich & Ehrenberg) (Hemiptera: Pseudococcidae) infested branches and leaves from Kermanshah.

Material studied: Kermanshah province: Kermanshah, *Prunus armeniaca* (Rosaceae), 8 adults (5♂, 3♀), 15.Apr.2021, 18.Apr.2021, 25.Apr.2021, Abedin Safari; Dalaho, *Prunus persica* (Rosaceae), 4 adults (1♂, 3♀), 22.Jul.2021, Abedin Safari; Islamabad-e-Gharb, *Malus domestica* (Rosaceae), 23 adults (10♂, 13♀), 29.Apr 2021, 3.May.2021, Abedin Safari; Ravansar, *Cydonia vulgaris* (Rosaceae), 23 adults (8♂, 15♀), 8.Jun.2021, Abedin Safari.

Regional distribution in Iran: Hamedan (Sadeghi & Khanjani, 1998), Isfahan (Jafari *et al*., 2002), Razavi Khorasan (Farahi & Sadeghi, 2009), Kerman (Jafari *et al*., 2013), Kermanshah (Khosravi *et al.*, 2014 and

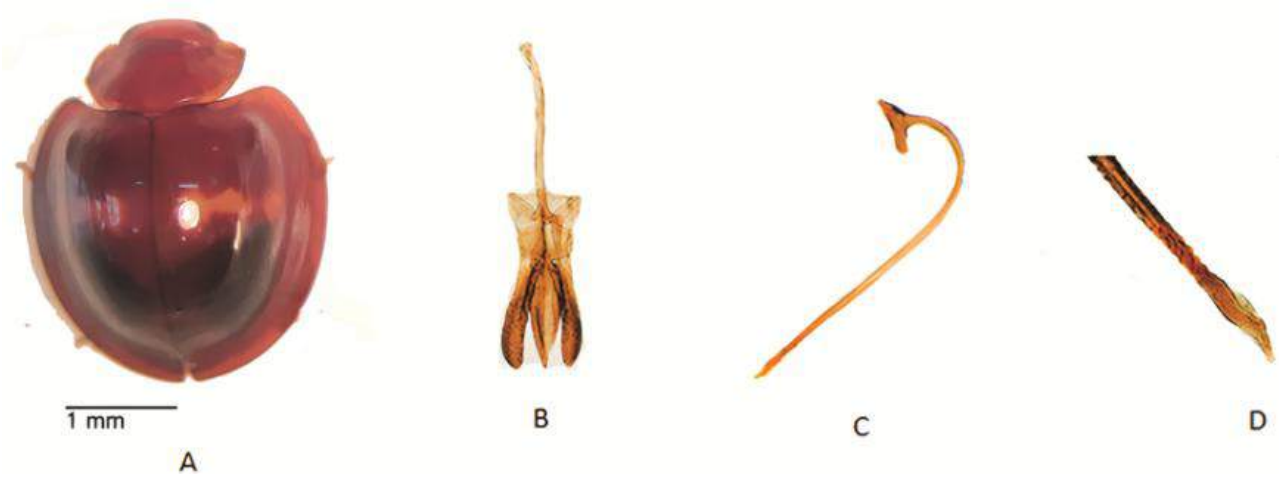

FIGURE 1. *Chilocorus bipustulatus*: A. Dorsal view, B. Ventral view of tegmen, C. Penis, D. Tip of penis, Body size : Length 3.2- 3.7 mm; Width 2.5- 2.8 mm (n = 5).

Naim, 1971), Tehran (Abdi *et al*., 2013), Lorestan (Mohammad poor *et al*., 2013), Yazd (Zare Khormizi *et al*., 2013), Semnan (Toozandejani and Ajamhassani, 2021).
Worldwide distribution: Afrotropical: Sudan (Yousof *et al*., 2013); Nearctic: USA (Gordon, 1985); wide distribution in Palearctic (Mader, 1955; Kovar, 2007) including Mongolia (Bielawski, 1975).

Genus *Exochomus* Redtenbacher, 1844

Exochomus quadripustulatus* (Linnaeus, 1758)
(Figures 2, 27C)
Syn.: *Coccinella 4-pustulata* Linnaeus, 1758
Notes: *Exochomus quadripustulatus* (Figs. 2, 27C) is commonly found on aphid infested oak and almond trees (branches and leaves) and collected manually. This is the first record of *E. quadripustulatus* from Kermanshah province.
Material studied: Dalaho, *Quercus* sp. (Fagaceae), *Prunus* sp. and *Amygdalus* sp. (Rosaceae), 24 adults (6♂, 18♀), 7.Apr.2021, 9.Apr.2021, 12.May.2021, Abedin Safari; Salas-Babajani, *Quercus* sp. (Fagaceae), 1 adult (1♂), 29.Mar.2021, Abedin Safari; Guilan-e-gharb, *Quercus* sp. (Fagaceae), 5 adults (1♂,4♀), 2.Apr.2021, Abedin Safari; Kermanshah, *Prunus* sp. and *Amygdalus* sp. (Rosaceae), 10 adults (2♂, 8♀), 15.Apr.2021, 30.Apr.2021, Abedin Safari.
Regional distribution in Iran: Alborz, Hamadan, Kohgiluyeh and Boyer-Ahmad, North Khorasan and Zanjan (Abdolahi *et al*., 2017), Lorestan (Mohammad poor *et al*., 2013), Kerman (Salehi *et al*., 2011), Tehran (Abdi *et al*., 2013 and Abdolahi *et al*., 2017) and Yazd (Zare Khormizi *et al*., 2013), Semnan (Toozandejani and Ajamhassani, 2021).
Worldwide distribution: USA (Gordon, 1985); Oriental: India (Poorani, 2004); Palearctic: wide distribution in western Palearctic (Mader, 1955; Kovar, 2007) and Russia (Poorani, 2004).

***Exochomus undulatus* Weise, 1878**
(Figures 3, 27B)
Notes: In this research, the ladybird, *Exochomus undulatus* (Figs. 3, 27B) was collected from the mountain pistachio trees, *Pistacia mutica*, which were infected by both the common pistachio psylla, *Agonoscena pistaciae* Burckhardt & Lauterer (Aphalaridae), and pistachio galling aphids (Aphididae). It was collected manual and direct methods, beating tray and netting.

Previously, it was collected from Pistachio in Kerman (Salehi *et al*., 2011), and by Khosravi et al. (2014), on *Trabutina mannipara* (Hemiptera: Pseudococcidae) infested *Tamarix* branches and leaves, from Kermanshah. Also, it has already been reported by Gholami Moghadam et al., (2014) from Kermanshah and found on *Euphyllura olivina* (Hemiptera: Psyllidae) (Moddarres-Awal 2012).

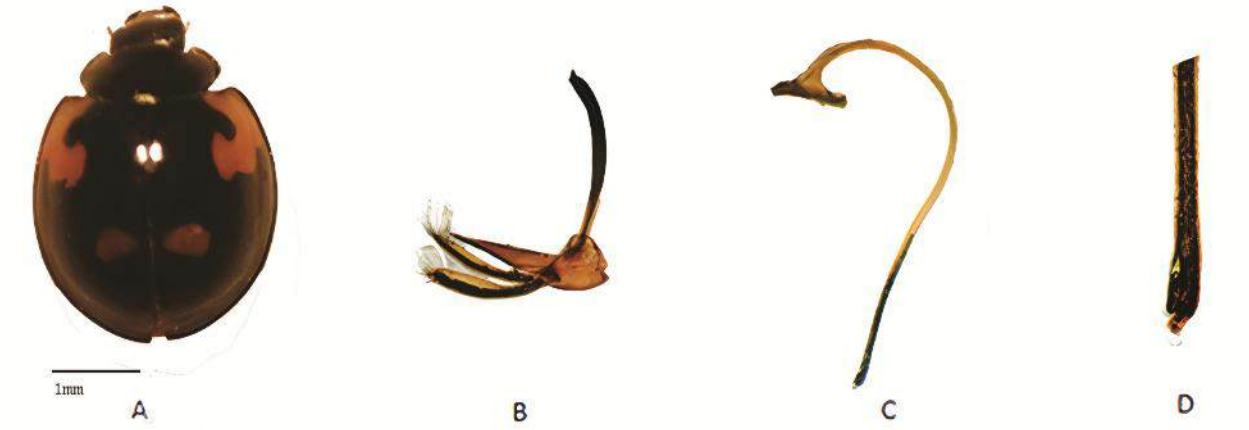

FIGURE 2. *Exochomus quadripustulatus*: (A) Dorsal view, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 3.5- 4.2 mm; Width 2.7- 3.6 mm (n = 5).

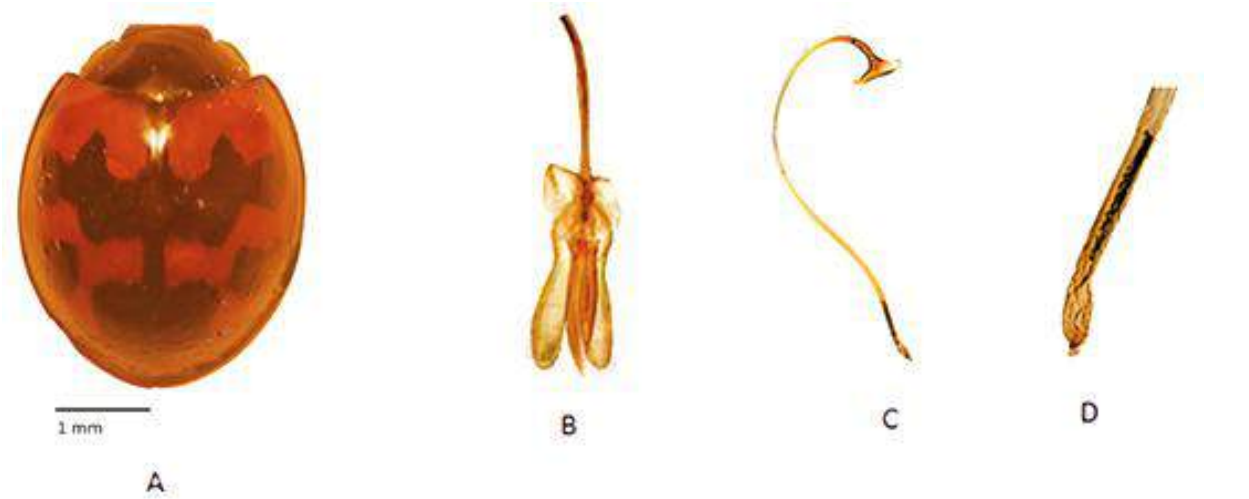

FIGURE 3. *Exochomus undulatus*: (A) Dorsal view of adult female, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 3.2- 4.3 mm; Width 2.5- 3.6 mm (n = 5).

Material studied: Kermanshah, *Pistacia mutica* (Anacardiaceae), 15 adults (8♂, 7♀), 29.Aug.2020, 28.Sep.2020, 6. Oct. 2020, 1.Sep.2021, 9.Aug.2021, 8.Sep.2021 Hadis Nehrangi. *Salix* sp. (Salicaceae), 25 adults (8♂,17♀), 25.Oct.2020, 30.Oct.2020, 12.Nov.2020, 18.Nov.2020, 14.Feb.2021, Abedin Safari; Qasr-e Shirin and Sarpol-Zahab, *Punica* sp. (Lythraceae), *Quercus* sp. (Fagaceae), 38 adults (17♂,21♀), 18.Nov.2020, 27.Nov.2020, Abedin Safari; Islamabad-e-Gharb, *Quercus* sp. (Fagaceae), 13 adults (4♂, 9♀), 8.Dec.2020, 15.Dec.2020, Abedin Safari; Dallaho, *Vitis* sp. (Vitaceae), *Quercus* sp. (Fagaceae), *Prunus* sp., *Amygdalus* sp. and *Malus domestica* (Rosaceae), 41 adults (14♂, 27♀), 4.Mar.2021, 9.Mar.2021, 13.Mar.2021, Abedin Safari; Sonqor, *Robinia* sp. and *Medicago sativa* (Fabaceae), 33 adults (10♂, 23♀), 15.May.2021, 29.Sep.2021, Abedin Safari.

Regional distribution in Iran: Hamadan, Kohgiluyeh and Boyer-Ahmad, Tehran and Zanjan (Abdolahi *et al*., 2017), Kerman (Salehi *et al*., 2011), Kermanshah (Khosravi *et al.*, 2014 and Gholami Moghadam *et. al*. 2014), Razavi Khorasan (Farahi & Sadeghi, 2009), Tehran (Ghanbari *et al*., 2012), Lorestan (Mohammad poor *et al*., 2013).

Worldwide distribution: Palearctic: Afghanistan, Albania, Egypt, Georgia, Iran, Iraq, Israel, Lebanon, Syria, (Kovar, 2007), Uzbekistan (Mader, 1955).

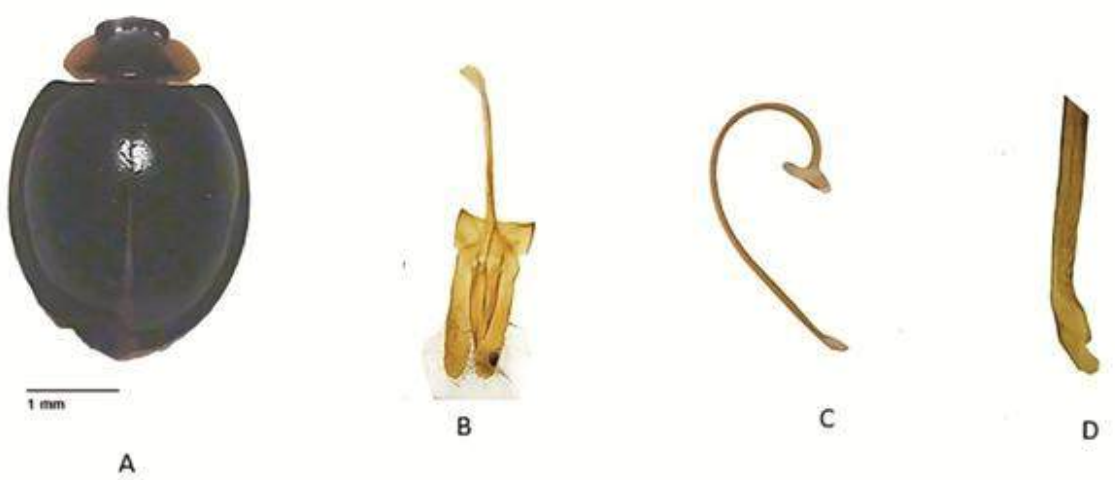

FIGURE 4. *Parexochomus nigromaculatus*: (A) Dorsal view of the ladybug, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 3.2- 4 mm; Width 2.7- 3 mm (n = 5).

Genus *Parexochomus* Barovskij, 1922

***Parexochomus nigromaculatus* (Goeze, 1777)**
(Figures 4, 27D)
Syn.: *Coccinella nigromaculata* Goeze, 1777
Notes: In this study, the ladybird species *P. nigromaculatus* (Figs. 4, 27D) was collected from mountain pistachio trees, *Pistacia mutica*, which were affected by both the common pistachio psylla, *Agonoscena pistaciae* Burckhardt & Lauterer (Aphalaridae), and galling aphids (Aphididae). Furthermore, specimens were also collected from cultivated pistachio trees, *Pistacia vera*, which were similarly infested by the common pistachio psylla, *Agonoscena pistaciae* Burckhardt & Lauterer (Aphalaridae). The ladybird *Parexochomus nigromaculatus* has been reported by Khosravi *et al.* (2014), as *Exochomus nigromaculatus* (Goeze, 1777) on *Trabutina mannipara* (Hemiptera: Pseudococcidae), on *Tamarix* sp. from Kermanshah.
Material studied: Kermanshah, *Pistacia mutica*, 5 adults (1 ♂, 4♀), 29.Aug.2020, Hadis Nehrangi; *Pistacia vera*, 7 adults (2 ♂, 5♀), 16.Aug.2021, Hadis Nehrangi. *Medicago sativa* and *Astragalus* sp., (Fabaceae), 25 adults (12 ♂, 13♀), 8.Sep.2020, 18.Sep.2021, 7.Oct.2021, Abedin Safari;Dalaho, *Carthamus tinctorius* (Asteracae), *Astragalus* sp., (Fabaceae), 25 adults (8♂, 17♀), 6.May.2020, 9.May.2020, 4.Jun.2021, 13.Jun.2021, Abedin Safari; Islamabad-e-Gharb, *Medicago sativa* (Fabaceae), 19 adults (7♂, 12♀), 27.Sep.2020, 3.Oct.2021, 11.Oct.2021, 15.Nov.2021, Abedin Safari; Javanrod, *Medicago sativa* (Fabaceae), 7 adults (5♂,2♀), 23.Jun.2021, Abedin Safari; Sahneh, *Amaranthus* sp., (Amaranthacae), *Medicago sativa* (Fabaceae), which infested by Aphidoidea; 11 adults (3♂, 8♀), 1.Sep.2021, Abedin Safari.
Regional distribution in Iran: Kermanshah (Khosravi *et al.*, 2014), Lorestan (Jafari et al., 2007), Mazandaran (Pahlavani *et al*., 2017), Razavi Khorasan (Farahi & Sadeghi, 2009), Kerman (Jafari *et al*., 2011), Tehran (Ghanbari *et al*., 2012), Semnan (Toozandejani and Ajamhassani, 2021).
Worldwide distribution: Nearctic: USA (Gordon, 1985); Palearctic: wide distribution (Mader, 1955; Kovar, 2007)

Parexochomus pubescens* (Kuster, 1848)
(Figures 5, 27E)
Syn.: *Exochomus pubescens* Kuster, 1848
Notes: The ladybird *Parexochomus pubescens* (Figs. 5, 27E) is associated with Aleyrodioidea, Coccoidea and Acari.This is the first record of *Parexochomus pubescens* from Kermanshah province. The sample was collected directly by hand, beating tray and netting.

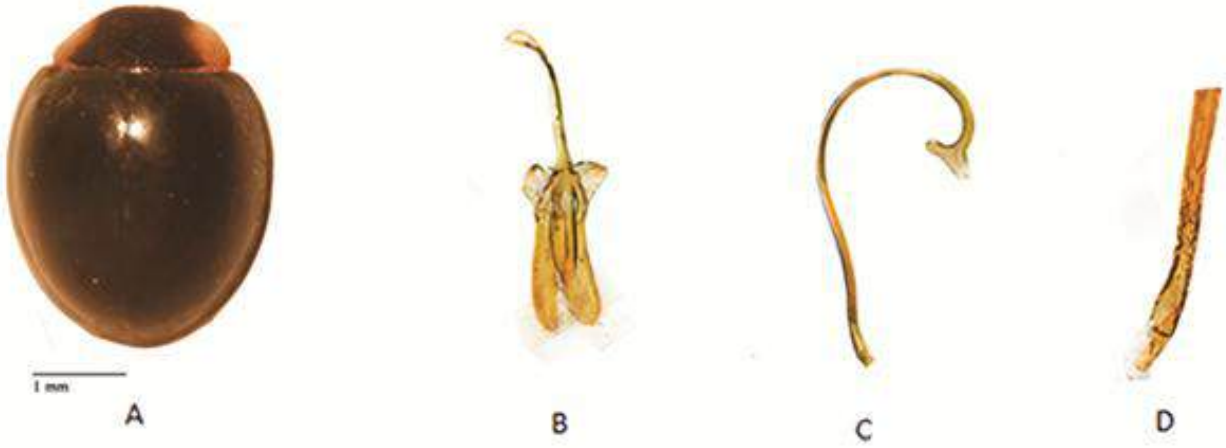

Figure 5. *Parexochomus pubescens*: (A) Dorsal view of adult, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 2.3- 3 mm; Width 1.9- 2.6 mm (n = 5).

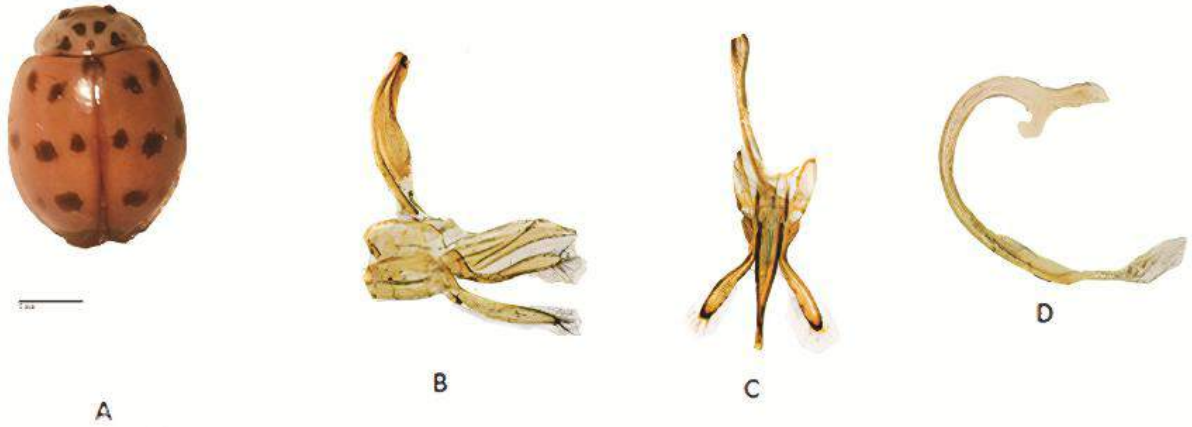

FIGURE 6. *Adalia bipunctata*: (A) Dorsal view, (B) Lateral sides of tegmen, (C) Ventral view of tegmen, (D) Penis, Body size : Length 3.4- 4.1 mm; Width 2.7- 3.4 mm (n = 5).

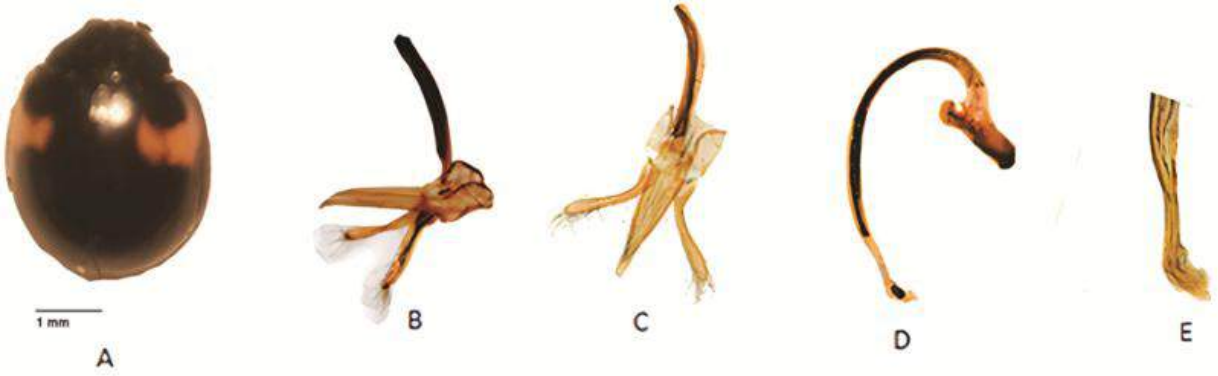

FIGURE 7. *Adalia decempunctata*, (A) Dorsal view, (B) Lateral sides of tegmen, (C) Ventral view of tegmen, (D) Penis, (E) Tip of penis, Body size: Length 3.5- 4.4 mm; Width 2.8- 3.7 mm (n = 5)**.**

Material studied: Gahvareh, *Echinops* sp. (Asteraceae) and *Astragalus* sp. (Fabaceae), 33 adults (18♂, 15♀), 10.Aug.2021, 13.Aug.2021, 19.Aug.2021, Abedin Safari; Islamabad-e-Gharb, *Carthamus* sp. (Asteracae), 10 adults (5♂, 5♀), 7.Sep.2021, 13.Sep.2021, Abedin Safari.
Regional distribution in Iran: Alborz, Hamadan, Sistan and Baluchistan and Tehran (Abdolahi *et al*., 2017), Lorestan (Mohammad poor *et al*., 2013), Kerman (Jafari *et al*, 2011), Tehran (Samin & Shojai, 2013).
Worldwide distribution: Africa (Raimundo & Van Harten, 2000); Oriental: India (Raimundo *et al*., 2008); Palearctic: Afghanistan, Algeria, Egypt, France, Germany, Iran, Iraq, Israel, Italy, Lebanon, Morocco, Pakistan, Saudi Arabia, Spain, Tunisia (Kovar, 2007), Transcaucasia (Mader, 1955) and Turkey (Efil *et al*., 2010).

Tribe COCCINELLINI
Genus *Adalia* Mulsant, 1846

***Adalia bipunctata* (Linnaeus, 1758)**
(Figures 6, 28C)
Syn.: *Coccinella 2-punctata* Linnaeus, 1758
Notes: *Adalia bipunctata* (Figs. 6, 28C) shows a morphological variation in the background color and spot number, which is reliable with the results of (Honek et al., 2005; Zare et al., 2012). It was collected from Pistachio, apple and peach trees, directly by hand and from aphid colonies. Different forms were collected during the sampling. Previously it has been reported by Gholami Moghadam *et. al*. (2014) from Kermanshah. Also, it was collected from Pistachio trees in Kerman (Salehi *et al*., 2011)
Material studied: Kermanshah, *Pistacia mutica*, 7 adults (2 ♂, 5♀), 29.Aug.2020, Hadis Nehrangi; *Pistacia vera*, 5 adults (2 ♂, 3♀), 16.Aug.2021, Hadis Nehrangi. *Prunus persica* (Rosaceae), *Malus domestica* (Rosaceae), 40 adults (17♂, 23♀), 30.May.2021, 11.Jul.2021, 19Jul.2021, Abedin Safari; Gahvareh, *Prunus persica* (Rosaceae), 27 adults (8♂, 19♀), 25.Apr.2021, 13,Jun.2021, 28.Jun.2021, Abedin Safari; Hersin, *Prunus persica* (Rosaceae), *Malus domestica* (Rosaceae), 18 adults (5♂, 13♀), 6.May.2021, 9.May.2021, Abedin Safari;
Regional distribution in Iran: Golestan (Abdolahi *et al*., 2017), Isfahan (Jafari *et al*., 2002), Mazandaran (Pahlavani *et al*., 2017), Kerman (Jafari *et al*., 2011), Kermanshah (Gholami Moghadam *et. al*. 2014), Lorestan (Mohammad poor *et al*., 2013), Yazd (Zare Khormizi *et al*., 2013) and Semnan (Toozandejani and Ajamhassani, 2021).
Worldwide distribution: Afrotropical: Middle of Africa (Bielawski, 1975); Nearctic: USA (Gordon, 1985) and Canada (Larson, 2013); Neotropical: introduced to Chile (Rebolledo et al., 2007); Oriental: India, (Poorani, 2004); Palearctic: wide distribution (Kovar, 2007), including Mongolia (Beilawski, 1975) and China (Poorani, 2004).

Adalia decempunctata* (Linnaeus, 1758)
(Figures 7, 28B)
Syn.: *Coccinella decempunctata* Linnaeus, 1758
Notes: *Adalia decempunctata* (Figs. 7, 28B) is reported for the first time from Kermanshah province. This species has a morphological variation in the background color and spot number (Honek *et al*., 2005). This species was collected by hand, from the oak forest, during winter time, on the leaves left on the tree. Additionally, from the peach, walnut and grape trees, infested by aphid, during spring and summer.
Material studied: Iran: Gilan-Gharb, *Quercus* sp. (Fagaceae), 23 adults (8♂, 15♀), 22.Dec.2020, 25.Dec.2020, 8.Feb.2021, Abedin Safari; Islamabad-e-Gharb, *Quercus* sp.p (Fagaceae), 29 adults (14♂, 25♀), 29.Dec.2020, 28.Feb.2020, Abedin Safari; Dalaho, *Prunus persica* (Rosaceae), 79 adults (25♂, 54♀), 1.Mar.2021, 8.Mar.2021, 12.Mar.2021, 25.Mar.2021, 8.Apr.2021, Abedin Safari; Kermanshah, *Juglans* sp. (Juglandaceae), 26 adults (9♂, 17♀), 15.Apr.2021, 22.Apr.2021, Abedin Safari; Hersin, *Prunus persica* (Rosaceae), 16 adults (5♂, 11♀), 7.May.2021, 9.May.2021, Abedin Safari; Ravansar and Javanrod, *Prunus persica* (Rosaceae), *Juglans* sp. (Juglandaceae), 40 adults (9♂, 31♀), 11.Jun.2020, 20.Jun.2021, Abedin Safari.

Regional distribution: Iran: Alborz, Golestan, Hormozgan and North Khorasan and Tehran (Abdolahi *et al*., 2017), Fars (Yazdani, 1990), Mazandaran (Pahlavani *et al*., 2017), Isfahan (Haghshenas *et al*., 2004), Kerman (Jafari *et al*., 2011), Markazi (Haghshenas *et al*., 2004), Lorestan (Mohammad poor *et al*., 2013), Hamedan (Akhavan *et al*., 2013 and Abdolahi *et al*., 2017)), Semnan (Toozandejani and Ajamhassani, 2021).
Worldwide distribution: western Palearctic (Kovar, 2007), including Mongolia (Bielawski, 1975); Oriental: India (Lal & Kanakavalli, 1960).

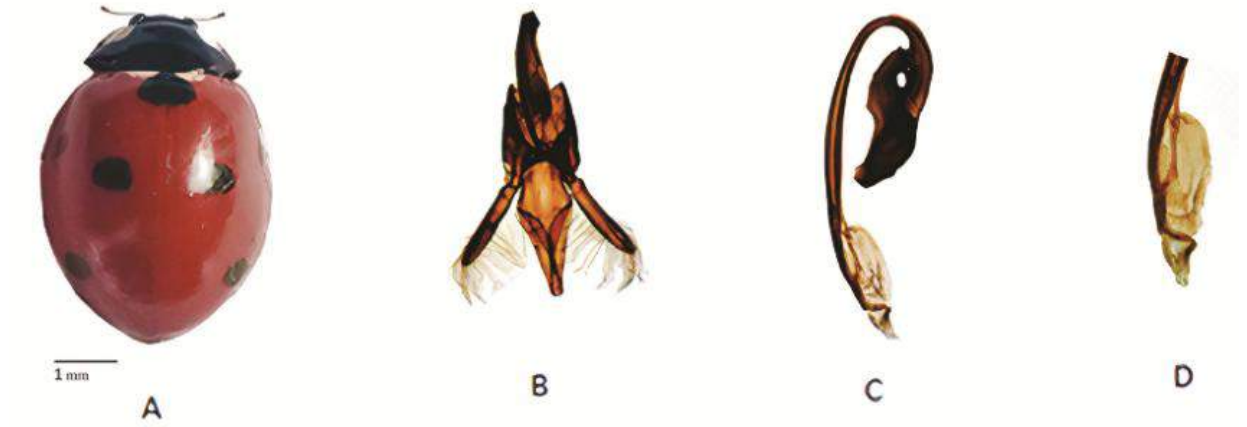

FIGURE 8. *Coccinella septempunctata*: (A) Dorsal view, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 4.5- 6.2 mm; Width 3.5- 5.5 mm (n = 5)**.**

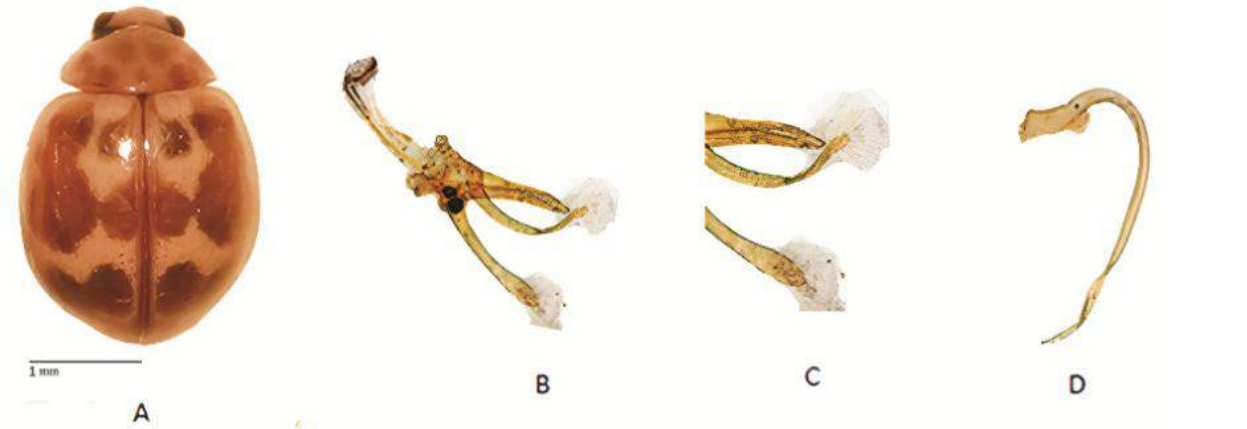

FIGURE 9. *Coccinula elegantula*, (A) Dorsal view (B) Tegmen, (C) Basal lobe and parameres, (D) Penis, Body size : Length 2.5- 2.9 mm; Width 1.8- 2.2 mm (n = 5).

Genus *Coccinella* Linnaeus, 1758

Coccinella septempunctata Linnaeus, 1758
(Figures 8, 27F)

Notes: The ladybug, *Coccinella septepunctata* (Figs. 8, 27F) was collected from natural habitats and agroecosystems on different crop plants, weeds and trees, including Pistachio trees infested by galling aphids (Aphididae), *A. pistaciae* (Aphalaridae) and *S. stali* (Cicadellidae) in Kermanshah province. Also, it was collected from Pistachio trees in Kerman (Salehi *et al*., 2011).
Material studied in Iran: With wide geographic distribution in Kermanshah. *Pistacia mutica*, 12 adults (4♂, 8♀), 29.Aug.2020, Hadis Nehrangi; *Pistacia vera*, 6 adults (3♂, 3♀), 16.Aug.2021, Hadis Nehrangi;

various plants, 137 adults (30♂, 107♀), 10.Jun.2020, 16.Jun.2020, 4.Jul.2020, 3.Aug.2020, 14.Aug.2020, 5.Sep.2020, 22.Sep.2020, 8.Oct.2020, 27.Oct.2020, 4.Nov.2020, 12.Mar.2021, 13.May.2021, 14.Jun.2021, 11.Aug.2021, 10.Sep.2021, 15.Oct.2021, 25.Feb.2022, Abedin Safari; Dalaho, 173 adults (80♂, 93♀), 28.Feb.2020, 10.Mar.2020, 22.Mar.2020. 14.Apr.2020, 25.Apr.2020, 5.May.2020, 12Jun.2020, 19.Jun.2020, 8.Jul.2020, 7.Aug.2020, 13.Sep.2020, 2.Oct.2020, 22.Oct.2020, 13.Mar.2021, 25.Mar.2021,22.Jun.2021, 28.Jul.2021, 6.Aug.2021, 3.Sep.2021, 19.Oct.2021, 1.Nov.2021, 5.Mar.2022, Abedin Safari; Islamabad-e-Gharb, 139 adults (49♂, 70♀), 5.May.2020, 4.Jun.2020, 28.Aug.2020, 8.Nov.2020, 9.Aug.2021, 17.Sep.2021, 9.Oct.2021, 28.Feb.2021, Abedin Safari; Ravansar, 63 adults (23♂, 40♀), 23.Mar.2021, 18.Jun.2021, 7.May.2022, Abedin Safari; Gilane-Gharb, 84 adults (24♂, 60♀), 6.Mar.2021, 2.Apr.2021, 14.Apr.2021, Abedin Safari; Salas- Babajani, 27 adults (7♂, 20♀), 29.Mar.2021, 26.Apr.2021, 13.Jun.2021, Abedin Safari; Sonqor, 48 adults (8♂, 40♀), 15.May.2021, 14.Jul.2021,Abedin Safari; Sahneh, 45 adults (12♂, 33♀), 15.Jul.2021, 19.Sep.2021, 1.Oct.2021; Javanrod, 99 adults (20♂, 79♀), 23.Mar.2021, 18.Jun.2021, 7.May.2022; Kangavar, 32 adults (14♂, 18♀), 15.Jul.2021, 19.Sep.2021, 1.Oct.2021, Abedin Safari; Sarpol-Zahab, 49 adults (22♂, 27♀), 11.Mar.2021, 18.Mar.2021, 9.Apr.2021, Abedin Safari; Qasr-Shirin, 40 adults (8♂, 32♀), 11.Mar.2021, 18.Mar.2021, 9.Apr.2021, Abedin Safari; Harsin, 39 adults (9♂, 30♀), 3.Apr.2021, 19.Sep.2021, Abedin Safari; Paveh, 15 adults (4 ♂, 11♀), 18.Oct.2022, Abedin Safari.

Notes: Many samples were strongly female-biased, which might be of an indication of presence of male killing bacteria in the populations.

Regional distribution in Iran: This species exhibits a broad geographic range, including, Lorestan (Mohammad poor *et al*., 2013), Razavi Khorasan (Farahi & Sadeghi, 2009), Kerman (Jafari *et al*., 2011), Tehran (Ghanbari *et al*., 2012), Mazandaran (Pahlavan *et al*., 2017).

Worldwide distribution: USA (Gordon, 1985), Canada (Larson, 2013); Oriental: India (Bielawski, 1968; Canepari, 2011), Sri Lanka (Ashfaque, 2012), Pakistan (Poorani, 2004); Palearctic: wide distribution; Afrotropical (Kovar, 2007).

Genus *Coccinula* Dobzhansky, 1925

***Coccinula elegantula* Weise, 1890**

(Figures 9, 28F)

Notes: *Coccinula elegantula* (Figs. 9, 28F) was collected directly by hand from both Pistachio and pine trees. This species was previously reported by Jalilvnd (2014) from Kermanshah province.

Material studied: Kermanshah (Taq-e-Bostan mountains), *Pistacia mutica*, 5 adults (3 ♂, 2♀), 29.Aug.2020, Hadis Nehrangi; (Agricultural College), *Pistacia vera*, 4 adults (0 ♂, 4♀), 16.Aug.2021, Hadis Nehrangi; *Pinus* sp. (Pinaceae), 7 adults (3♂, 4♀), 9.Dec.2020, 19.Dec.2020, 8.Jan.2021, 30.Apr.2021, Abedin Safari.

Regional distribution in Iran: Kermanshah (Jalilvnd, 2014), Razavi Khorasan (Yaghmaee & Kharaji, 1995), Isfahan (Jafari *et al*., 2002), Lorestan (Mohammad poor *et al*., 2013), Yazd (Zare Khormizi *et al*., 2013)

Worldwide distribution: Palearctic: Russia, Iran, Kazakhstan, Mongolia, Uzbekistan, Kyrkyzstan, Tadzhikistan (Kovar, 2007), Mongolia and Turkestan (Duverger, 1983)

Coccinula redimita* Weise, 1885

(Figures 10, 28G)

Notes: *Coccinula redimita* (Figs. 10, 28G) is reported for the first time from Kermanshah province.

Material studied: Dalaho (Gahvareh, Ghale-Ghazi Village), *Astragalus* sp. (Fabaceae), 8 adults (3♂, 5♀), 19.Jul.2021, 26.Jul.2021, Abedin Safari.

Regional distribution: Iran: Chaharmahal Bakhtiari (Bagheri & Mossedegh, 1995), Tehran (Borumand, 2000), Isfahan, Lordegan (Ghanbari Kohyani *et al*., 2013)

Worldwide distribution: Palearctic: Afghanistan, Iran, Tadzhikistan, Uzbekistan (Kovar, 2007), Turkey & Pakistan (Ashfaque, 2012) and Mongolia (Bielawski, 1975)

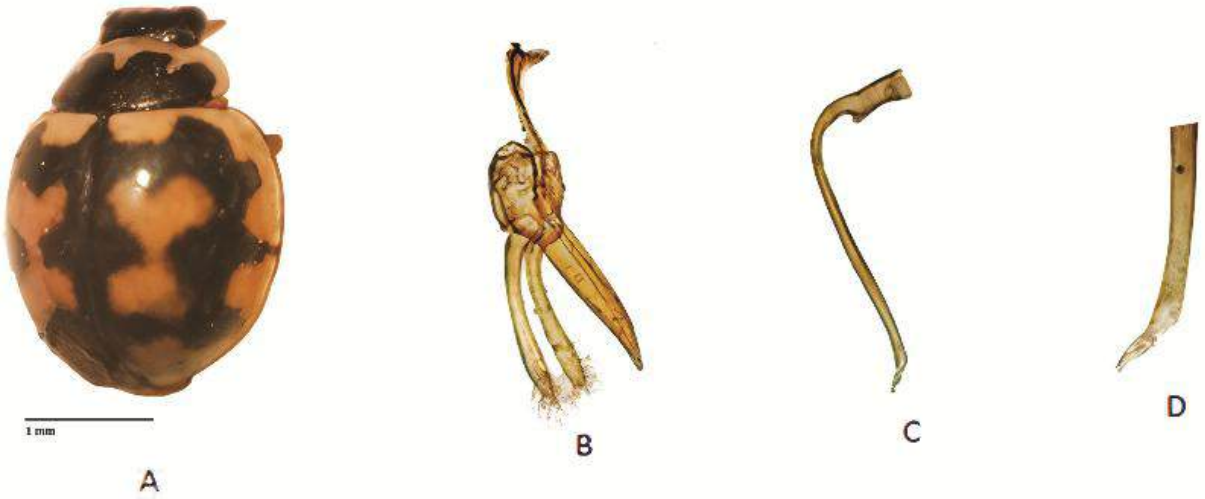

FIGURE 10. *Coccinula redimita*, (A) Dorsal view, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 2.8- 3.4 mm; Width 2.1- 2.6 mm (n = 5).

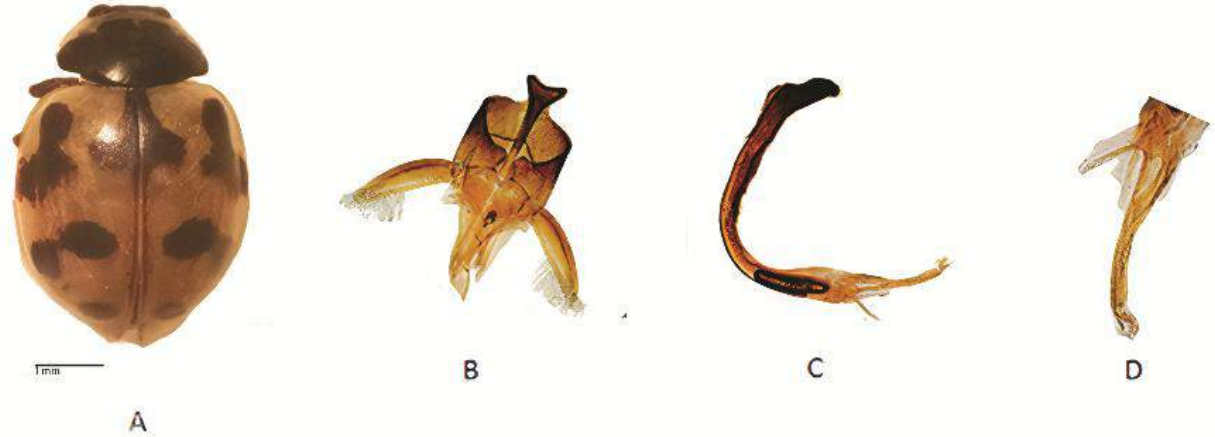

FIGURE 11. *Hippodamia undecimnotata*, (A) Dorsal view, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 4.2- 5.1 mm; Width 3.6- 4.5 mm (n = 5).

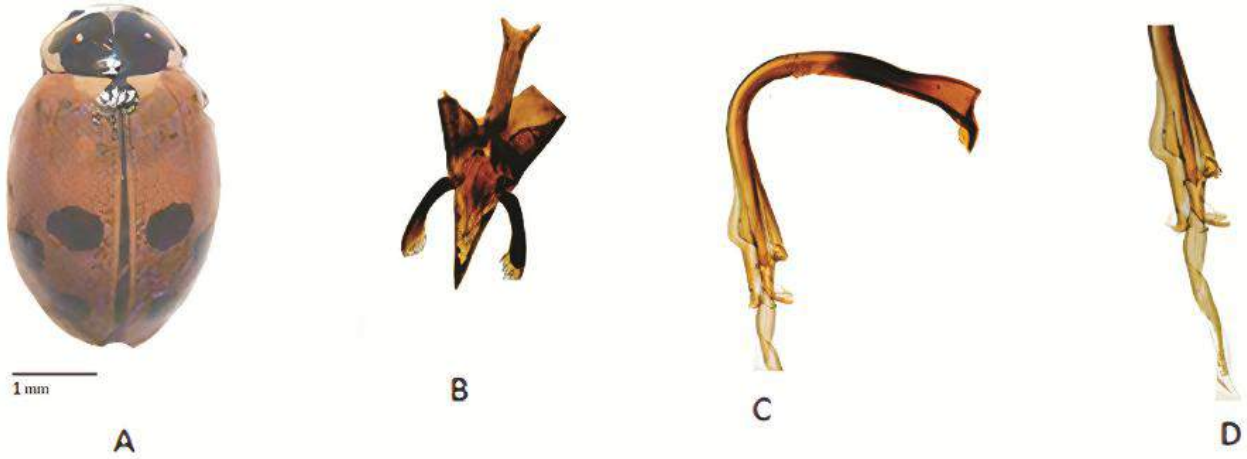

FIGURE 12. *Hippodamia variegata*: (A) Dorsal view of female, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 3.5- 4.7 mm; Width 2.6-3.5 mm (n = 5).

Genus *Hippodamia* Chevrolat, 1836

***Hippodamia undecimnotata* (D.H. Shneider, 1793) ***
(Figures 11, 28D)
Syn.: *Coccinella undecimnotata* D.H.Schneider, 1792
Ceratomegilla undecimnotata (Schneider, 1792)
Semiadalia undecimnotata (Schneider, 1792)
Notes: *Hippodamia undecimnotata* (Figs. 11, 28D) is reported for the first time from Kermanshah province. It was collected from *Centaurea*, weed plants, directly by hand, within aphid colony. It appears in molecular phylogeny that *Ceratomegilla undecimnotata* belongs to *Hippodamia*.
Material studied: Gahvareh (Chegha Bor village), *Centaurea* sp., 12 adults (5♂, 7♀), 2.May.2020, 12.May.2020, Abedin Safari.
Regional distribution: Iran: First time recorded from Iran by Kovar (2007*)*, without specification of province.
Worldwide distribution: Palearctic: wide distribution in western Palearctic (Kovar, 2007), Caucasus, Western Siberia, Asia Minor (Iablokoff-Khnzorian, 1982).

***Hippodamia variegata* (Goeze, 1777)**
(Figures 12, 27G)
Syn.: *Adonia variegata* Goeze, 1777
Notes: *Hippodamia variegata* (Figs. 12, 27G) is an entomophagous ladybird. It is associated with Aphidoidea, Coccoidea, leafhoppers, psylloidea and Lepidoptera larvae which linked with *Pistacia* spp (Anacardiacae).This species occur abundantly in natural habitats and agro-ecosystems on different crops and ornamental plants, weeds and trees. This species collected directly by hand and beating tray, with close observation. The largest number of the field collected samples belong to *H. variegata* (430♂, 800♀), which shows a morphological variation in the number and location of the elytral spots, which is reliable with the results of (Honek et al., 2012; Biranvand and Shakarami, 2015). Previously, it was collected from Pistachio in Kerman (Salehi *et al*., 2011).
Material studied in Iran: Kermanshah (Taq-e-Bostan mountains), *Pistacia mutica*, 7 adults (2 ♂, 5♀), 29.Aug.2020, Hadis Nehrangi; (Agricultural College), *Pistacia vera*, 5 adults (1 ♂, 4♀), 16.Aug.2021, Hadis Nehrangi; various plants, 199 adults (80♂, 119♀), 11.May.2020, 25.May.2020, 10.Jun.2020, 16.Jun.2020, 4.Jul.2020, 3.Aug.2020, 14.Aug.2020, 5.Sep.2020, 22.Sep.2020, 8.Oct.2020, 27.Oct.2020, 4.Nov.2020, 12.Mar.2021, 13.May.2021, 14.Jun.2021, 11.Aug.2021, 10.Sep.2021, 15.Oct.2021, 25.Feb.2022, Abedin Safari; Dalaho, 429 adults (123♂, 306♀), 28.Feb.2020, 1.Mar.2020, 10.Mar.2020, 22.Mar.2020. 14.Apr.2020, 25.Apr.2020, 5.May.2020, 12Jun.2020, 19.Jun.2020, 8.Jul.2020, 7.Aug.2020, 13.Sep.2020, 2.Oct.2020, 22.Oct.2020, 28.Oct.2020, 13.Mar.2021, 25.Mar.2021, 22.Jun.2021, 28.Jul.2021, 6.Aug.2021, 3.Sep.2021, 19.Oct.2021, 1.Nov.2021, 5.Mar.2022, Abedin Safari; Islamabad-e-Gharb, 119 adults (47♂,72♀), 5.May.2020, 4.Jun.2020, 28.Aug.2020, 8.Nov.2020, 9.Aug.2021, 17.Sep.2021, 9.Oct.2021, 28.Feb.2021, Abedin Safari; Ravansar, 102 adults (34♂, 68♀), 23.Mar.2021, 18.Jun.2021, 7.May.2022, Abedin Safari; Gilane-Gharb, 61 adults (18♂, 43♀), 6.Mar.2021, 2.Apr.2021, 14.Apr.2021, Abedin Safari; Salas-Babajani, 12 adults (3♂, 9♀), 29.Mar.2021, 26.Apr.2021, 13.Jun.2021, Abedin Safari; Sonqor, 52 adults (17♂, 35♀), 15.May.2021, 14.Jul.2021, Abedin Safari; Sahneh, 58 adults (21♂, 37♀), 15.Jul.2021, 19.Sep.2021, 1.Oct.2021; Javanrod, 22 adults(9♂, 13♀), 23.Mar.2021, 18.Jun.2021, 7.May.2022; Kangavar, 45 adults (19♂, 26♀), 15.Jul.2021, 19.Sep.2021, 1.Oct.2021, Abedin Safari; Sarpol-Zahab, 76 adults (34♂, 42 ♀), 11.Mar.2021, 18.Mar.2021, 9.Apr.2021, Abedin Safari; Qasr-Shirin, 25 adults (8♂, 17♀), 11.Mar.2021, 18.Mar.2021, 9.Apr.2021, Abedin Safari; Harsin, 12 adults (4♂, 8 ♀), 3.Apr.2021, 19.Sep.2021, Abedin Safari; Paveh, 13 adults (4 ♂, 9 ♀), 18.Sep.2022, 18.Oct.2022, Abedin Safari.
Note: Many samples were female-biased, which suggests a presence of male killing bacteria in the populations.

Regional distribution in Iran: Lorestan (Mohammad poor *et al*., 2013), Razavi Khorasan (Farahi & Sadeghi, 2009), Kerman (Jafari *et al*., 2011), Tehran (Ghanbari *et al*., 2012), Mazandaran (Pahlavani *et al*., 2017).

Worldwide distribution: Afrotropical: Kenya (Canepari, 2007), Central Africa (Raimundo & Van Harten, 2000), Eastern Africa (Ashfaque, 2012); Neotropical: introduced to Chile (Rebolledo et al., 2007); Oriental: India (Bielawski, 1968; Canepari, 2007), Nepal (Ashfaque, 2012); Palearctic: common distribution in China and other east Palearctic countries (Kovar, 2007), Tibet, China (Ashfaque, 2012) and Pakistan (Poorani, 2004).

Genus *Oenopia* Mulsant, 1850

Oenopia conglobata (Linnaeus, 1758)

(Figures 13, 27H)

Syn.: *Coccinella conglobata* Linnaeus, 1758;
Harmonia buphthalmus Mulsant, 1850;

Notes: *Oenopia conglobata* (Figs. 13, 27H) was collected directly by hand and beating tray technique, with a close observation on Pistachio trees infested by galling aphids (Aphididae), *A. pistaciae* (Aphalaridae) and *S. stali* (Cicadellidae). Previously, it was reported from Pistachio in Kerman (Salehi *et al*., 2011). Additionally, *Oenopia conglobata* specimens were collected from apple, walnut, plum, peach trees and alfalfa and corn fields infested by Aphidoidea. *Oenopia conglobata* has worldwide distribution, but originally belong to Asia, Europe and Africa. Reported as a psyllophagous and coccidophagus coccinellid (Mehrnejad, 2010 and Jalilvnd *et al*., 2014) from Iran, and as a predator of *Matsucoccus feytaudi* Ducasse (Hemiptera, Matsucoccidae) (Covassi et al., 1991).

Material studied in Iran: Kermanshah (Taq-e-Bostan mountains), *Pistacia mutica*, 21 adults (5♂, 16♀), 29.Aug.2020, Hadis Nehrangi; (Agricultural College), *Pistacia vera*, 4 adults (1♂, 3♀), 16.Aug.2021, Hadis Nehrangi; *Prunus persica* (Rosacea), *Juglans* sp. (Juglandaceae), *Medicago* sp. (Fabaceae) and *Zea mays* (Poaceae), 71 adults (28♂, 43♀), 9.Jun.2020, 19.Jun.2020, 18.Sep.2020, 17.Oct.2020, 29.Oct.2020, 11.Feb.2021, 26.Mar.2021. 19.Jun.2021, Aedin Safari; Dalaho, *Malus domestica*, *Prunus armeniaca* and *Prunus persica* (Rosacea), *Juglans* sp. (Juglandaceae), 73 adults (25♂, 48♀), 2.May2020, 5.May.2020, 17.May.2020, 15.Jun.2020, 5.Aug.2020, 13.Sep.2020, 25.Mar.2021, 22.May.2021, 17.Jun.2021, 1.Jul.2021, Abedin Safari; Gilan-Gharb, *Malus domestica*, *Prunus armeniaca* and *Prunus persica* (Rosacea), 14 adults (5♂, 9♀), 2.Apr.2021, 4.Apr.2021, Abedin Safari; Ravansar, *Juglans* sp. (Juglandaceae), 17 adults (10♂, 7♀), 7.May.2021, 18.Jun.2021, Abedin Safari Islamabad-e-Gharb, *Medicago* sp. (Fabaceae), *Malus domestica*, *Prunus armeniaca* and *Prunus persica* (Rosaceae), 47 adults (15♂, 32♀), 4.Jul.2020, 10.Jul.2021. 27Jul. 2021, Abedin Safari; Sahneh, *Malus domestica*, *Prunus armeniaca* and *Prunus persica* (Rosaceae), *Medicago* sp. (Fabaceae), 27 adults (8♂, 19♀), 18.May.2020, 22.Jun.2021, 1.Oct.2021, Abedin Safari; Paveh, *Prunus persica* (Rosaceae), 4 adults (1♂, 3♀), 18.Oct.2022, Abedin Safari.

Regional distribution in Iran: Kermanshah (Jalilvnd *et al*., (2014), Fars (Yazdani, 1990), Chaharmahal and Bakhtiari (Bagheri & Mosadegh, 1995), Gilan (Hajizadeh *et al*., 2002), Mazandaran (Pahlavan *et al*., 2017), Khuzestan (Ebrahimzadeh & Mosadegh, 2004), Lorestan (Mohammad poor *et al*., 2013), Isfahan (Jafari *et al*., 2002), Razavi Khorasan (Farahi & Sadeghi, 2009), Kerman (Salehi *et al*., 2011), Semnan (Toozandejani and Ajamhassani, 2021).

Worldwide distribution: North America (Ashfaque, 2012); Oriental: India (Sicard, 1907); Palearctic: wide distribution (Kovar, 2007), Northern China (Ashfaque, 2012) and Pakistan (Poorani, 2004).

Oenopia oncina (Olivier, 1808)

(Figures 14, 27I)

Notes: The ladybug, *Oenopia oncina* (Figs. 14, 27I) was collected from *Pistacia mutica*, infested by galling aphids (Aphididae) and *A. pistaciae* (Aphalaridae). Addition to this, collected from Pistachio in Kerman (Salehi *et al*., 2011). Also collected from an aphid colony associated with the host plant belonging to Asteraceae. The samples were directly collected by hand, with a close observation on the specimens. *Oenopia oncina* displays a sexual dimorphism. Male elytra with < 3 small brown spots, but

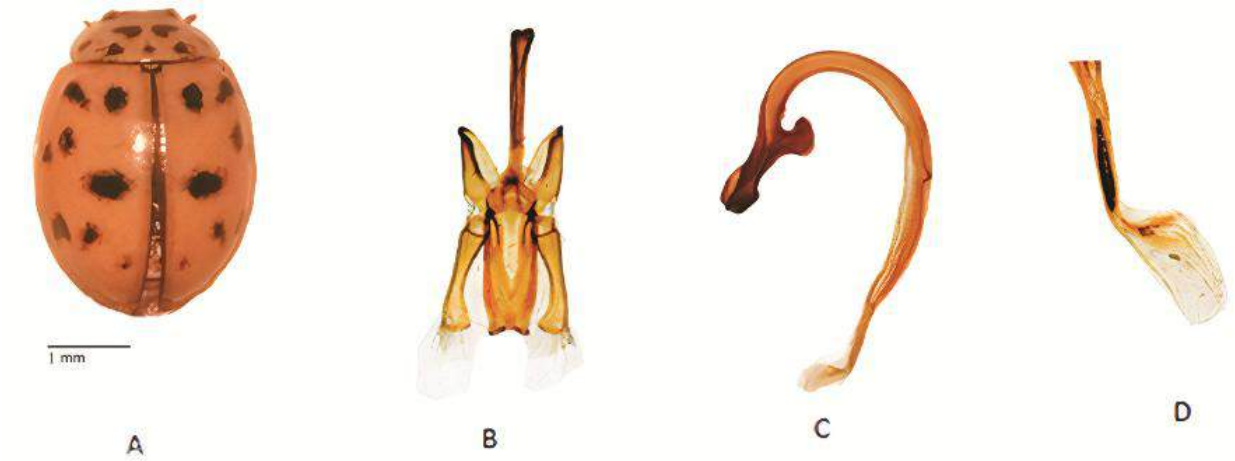

FIGURE 13. *Oenopia conglobata*: (A) Dorsal view, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 3.3- 4.2 mm; Width 2.3- 3.4 mm (n = 5).

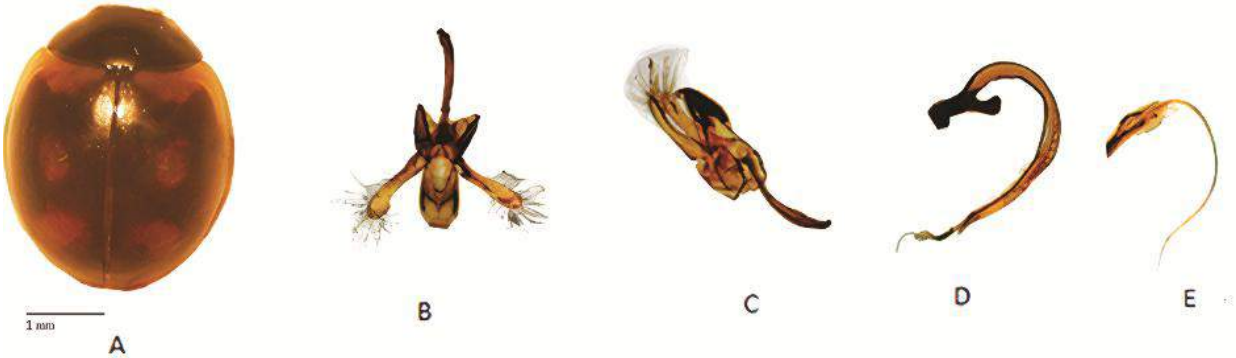

FIGURE 14. *Oenopia oncina* : (A) Dorsal view, (B) Ventral view of tegmen, (C) Lateral sides of tegmen, (D) Penis, (E) Tip of penis, Body size : Length 3.2- 4.1 mm; Width 2.4- 3.2 mm (n = 5).

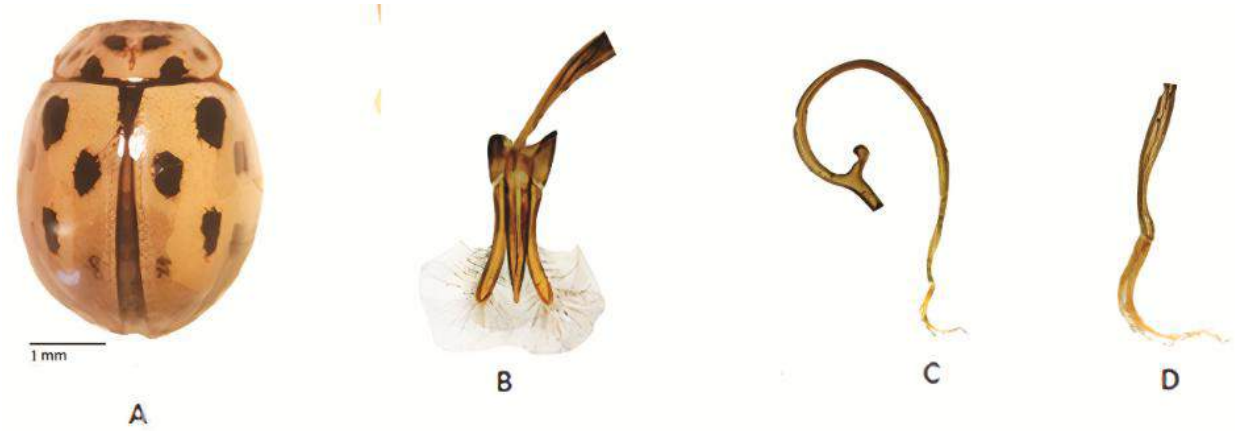

FIGURE 15. *Propylea quatuordecimpunctata*: (A) Dorsal view of female, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 3.8- 4.6 mm; Width 3.1- 4.2 mm (n = 5).

female elytra with ≥ 3 large brown spots. Previously, it was reported by Gholami Moghadam *et al*. (2014) from Kermanshah.

Material studied: Kermanshah (Taq-e-Bostan mountains), *Pistacia mutica*, 15 adults (5 ♂, 10♀), 29.Aug.2020, Hadis Nehrangi; Kermanshah, *Picnomon* sp. (Asteraceae), 8 adults (3♂, 5♀), 25.May.2021, 17.Sep.2021, Abedin Safari. Gehvareh, *Picnomon* sp. (Asteraceae), *Euphorbia* sp. (Euphorbiaceae), 29 adults (9♂, 20♀), 6.Oct.2020, 16.Oct.2020, 1.Nov.2021, Abedin Safari.

Regional distribution in Iran: Kermanshah (Gholami Moghadam *et. al*. 2014), Kerman (Jafari *et al*., 2011), Lorestan (Mohammad poor *et al*., 2013), Hamadan (Akhavan *et al*., 2013), Yazd (Zare Khormizi *et al*., 2013).

Worldwide distribution: Western Palearctic, Iran (Kovar, 2007)

Genus *Propylea* Mulsant, 1846

***Propylea quatuordecimpunctata* (Linnaeus, 1758) ***

(Figure 15, 28E)

Syn.: *Coccinella 14-punctata* Linnaeus, 1758

Notes: *Propylea quatuordecimpunctata* (Figs. 15, 28E) is reported for the first time from the Kermanshah province. It was collected by netting method from alfalfa fields infested by Aphidoidea. *Propylea quatuordecimpunctata* shows a sexual dimorphism. Male head yellow and in the middle part, female with dark spot on the clypeus.

Material studied: Kermanshah, *Medicago sativa* (Fabaceae), 68 adults (25♂, 43♀), 18.May.2021, 5.Jun.2021, 14.Jul.2021, Abedin Safari; Islamabad-e-Gharb, *Medicago sativa* (Fabaceae), 42 adults (15♂, 27♀), 4.Jun.2021, 16. Jun.2021, 3.Jul.2021, Abedin Safari.

Regional distribution: Iran: Alborz, Hormozgan, North Khorasan and Zanjan (Abdolahi *et al*., 2017), Gilan and Golestan (Abdolahi *et al*., 2017), Hamedan (Sadeghi & Khanjani, 1998 and Abdolahi *et al*., 2017)), Isfahan (Haghshenas *et al*., 2004), Razavi Khorasan (Farahi & Sadeghi, 2009), Kerman (Jafari *et al*., 2011), Tehran (Abdi *et al*., 2012 and Abdolahi *et al*., 2017), Lorestan (Mohammad poor *et al*., 2013), Semnan (Toozandejani and Ajamhassani, 2021).

Worldwide distribution: USA & Canada (Hoebeke & Wheeler, 1996); Oriental: India (Ashfaque, 2012), Bangladesh (Poorani, 2004); Palearctic: wide distribution (Kovar, 2007), including China (Ashfaque, 2012) and Pakistan (Poorani, 2004)

Genus *Psyllobora* Dejean, 1836

Psyllobora vigintiduopunctata* (Linnaeus, 1758)

(Figures 16, 28A)

Syn.: *Coccinella vigintiduopunctata* Linnaeus, 1758

Coccinella vigintipunctata Fabricius, 1775

Coccinella bisdecempunctata Duméril, 1817

Notes: *Psyllobora vigintiduopunctata* (Figs. 16, 28A) is reported for the first time from Kermanshah province. It is a mycophagous ladybird, associated with mildew. This species was collected from an alfalfa field with fungal disease (gray downy growth on the underside of leaflets) by netting and manual shaking plants. This ladybird shows sexual dimorphism, the pronotum background in male is lighter than the elytra.

Material studied: Gehvareh, *Torilis* sp. (Apiaceae), 33 adults (10♂, 23♀), 5.Sep.2020, 11.Oct.2020, 22.Oct.2020, 15.Jun.2021, Abedin Safari; Kermanshah, *Medicago sativa* (Fabaceae), 62 adults (27♂, 35♀), 19.May.2021, 23.May.2021, 28.Sep.2021, Abedin Safari; Biston, *Alhagi maurorum* and *Medicago sativa* (Fabaceae), 70 adults (28♂, 42♀), 27.May.2021, 7.Jun.2021, 29.Sep.2021, Abedin Safari.

Notes: Samples were female-biased, which suggests a presence of male killing bacteria in the populations.

Regional distribution: Iran: Lorestan (Mohammad poor *et al*., 2013), Mazandaran (Pahlavani *et al*., 2017), Hamedan (Sadeghi & Khanjani, 1998), Ardabil, Moghan (Lotfalizadeh, 2001), Semnan (Toozandejani and Ajamhassani, 2021).

Worldwide distribution: Palearctic (Kovar, 2007).

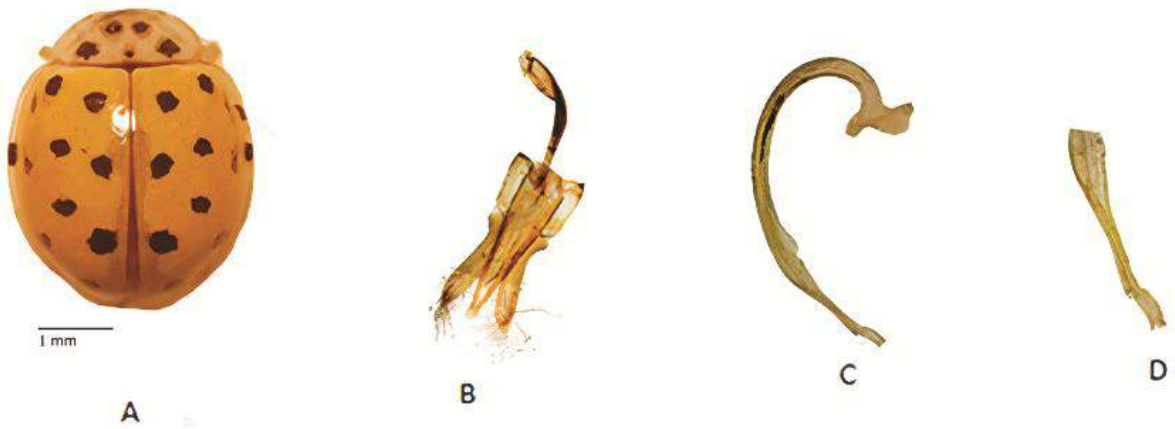

FIGURE 16. *Psyllobora vigintiduopunctata*, (A) Dorsal view, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 3.5- 4.5 mm; Width 2.6- 3.4 mm (n = 5)**.**

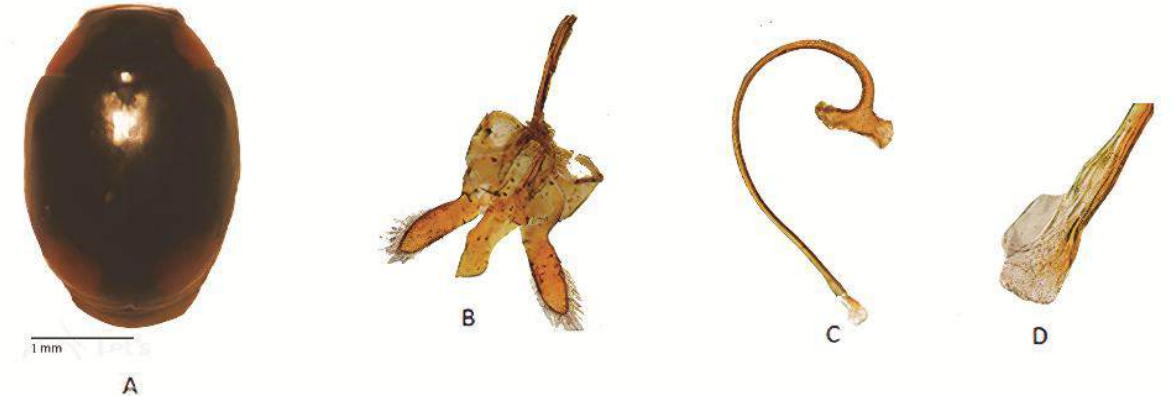

FIGURE 17. *Hyperaspis pseudopustulata*, (A) Dorsal view, (B) Tegmen, (C) Penis, (D) Tip op penis, Body size : Length 2.5- 3.8 mm; Width 2.2- 2.8 mm (n = 5)**.**

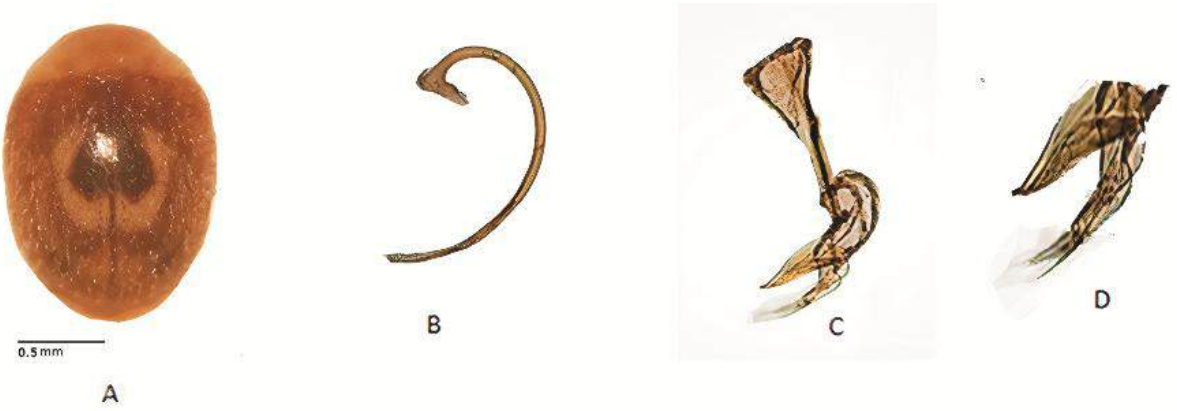

FIGURE 18. *Clitostethus arcuatus*, (A) Dorsal view, (B) Penis, (C) Tegmen, (D) Parameres and basal lobe, Body size : Length 1.6- 1.8 mm; Width 1.1- 1.3mm (n = 3)**.**

Tribe HYPERASPINIINI
Genus *Hyperaspis* Chevrolat 1837

***Hyperaspis pseudopustulata* Mulsant, 1853**
(Figures 17, 29G)

Notes: *Hyperaspis pseudopustulata* (Figs. 17, 29G) is a coccidophagus ladybird. It is associated with scale insect, *Anapulvinaria pistaciae* Bodenheimer, 1926 (Hem.: Coccidae) occurring sparsely in woodland areas on *Pistacia mutica*. This pistachio species is growing into shrubs and small trees, mainly in mountainous areas, 1500-2000 m above sea level. Also, collected from Pistachio in Kerman (Salehi *et al*., 2011). Additionaly, *H. pseudopustulata* is associated with other scale insect, *Orthezia urticae* (Linnaeus, 1758) (Orthzeiidae), occurring abundantly in hillside areas on three main host plants: *Eryngium thyrsoides* (Apiaceae), *Astragalus* sp. (Fabaceae) and *Euphorbia* sp. (Euphorbiaceae) (Karimi, 2018).

This ladybird species shows a fair degree of sexual dimorphism. Males with an additional small white spot on the head, anteriorly.

Material studied in Iran: Kermanshah (Taq-e-Bostan mountains), *Pistacia mutica*, 16 adults (5 ♂, 11♀), 29.Aug.2020, Hadis Nehrangi; Kermanshah, Sahneh, Dinavar, Balesht village, *Eryngium thyrsoides* (Apiaceae); *Astragalus* sp. (Fabaceae) and *Euphorbia* sp. 25 adults (9♂, 16♀), 22.Aug.2018, Hassanali vahedi and Samira Karimi; Dalaho, Gahvareh, Ghale-Ghazi village, *Astragalus* sp. (Fabaceae) and *Euphorbia* sp. (Euphorbiaceae), 20 adults (9♂, 11♀), 10.Aug.2021, 17.Aug.2021, Abedin Safari.

Regional distribution in Iran: Kermanshah (Karimi, 2018).

Worldwide distribution: Palearctic: Kazakhstan, Turkey and Asian parts of Russia (Kovář, 2007), semiaquatic plants in Europe (Nedvěd, 2015), Iran: Kermanshah (Karimi, 2018) and (Biranvand et al., 2019)**.**

Tribe SCYMNINI
Genus Clitostethus Weise, 1885

Clitostethus arcuatus* (Rossi, 1794)
(Figures 18, 29F)

Syn.: *Scymnus abeillei* Weise, 1884

Notes: *Clitostethus arcuatus* (Figs. 18, 29F) is reported for the first time from Kermanshah province. This species is very rare. It was collected with a beating tray.

Material studied: Iran: Kermanshah (Agricultural College), *Juglans* sp. (Juglandaceae), 3 adults (1♂, 2♀), 30.May.2021, Abedin Safari.

Regional distribution: Iran: ChaharMahal and Bakhtiari (Bagheri & Mosadegh, 1995), Golestan, North Khorasan and Tehran (Abdolahi *et al*., 2017), South Khorasan (Moadi & Mossadegh, 1995), Semnan (Toozandejani and Ajamhassani, 2021)

Worldwide distribution: western Palearctic, Iran (Kovar, 2007); Neotropical: introduced to Chile (Canepari, 2011); Afrotropical (Kovar, 2007).

Genus *Diomus* Mulsant, 1850

***Diomus rubidus* (Motschulsky, 1837)**
(Figures 19, 29E)

Syn.: *Scymnus rubidus* Motschulsky, 1837

Notes: *Diomus rubidus* (Figs. 19, 29E) was reported by Jalilvand *et al*. (2014) from Kermanshah province.

Material studied: Iran: Kermanshah, *Convolvulus* sp. (Convolvulaceae), 29 adults (12♂, 17♀), 14.May.2021, 17.May.2021, 8.Jun.2021, Abedin Safari.

Regional distribution: Iran: Kerman (Kouhpayezadeh & Mosadegh, 1991) and Kermanshah (Jalilvand *et al*., 2014).

Worldwide distribution: Western Palearctic (Kovar, 2007).

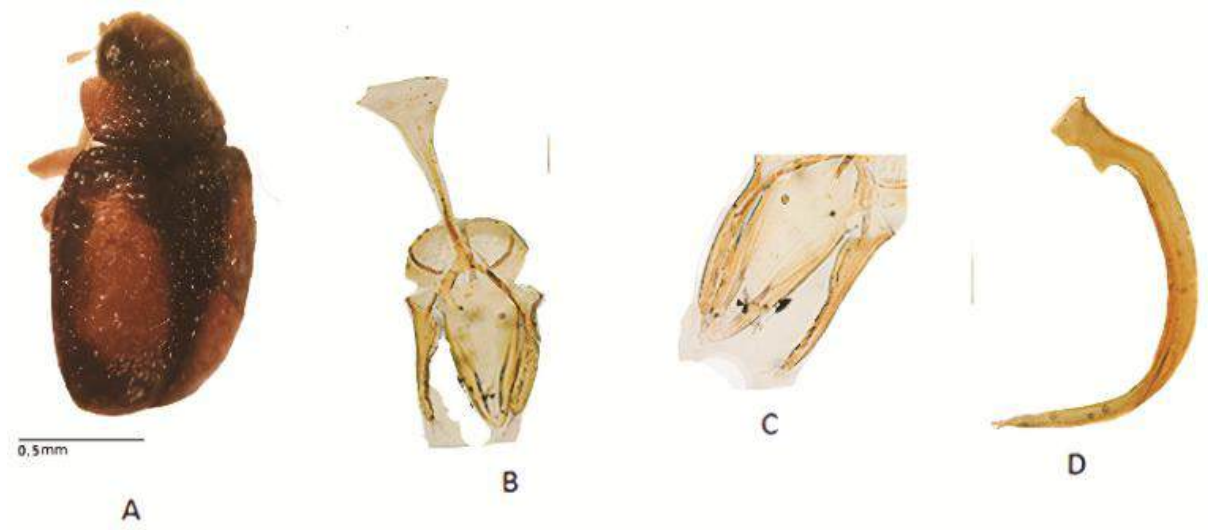

FIGURE 19. *Diomus rubidus*, (A) Dorsal view, (B) Tegmen, (C) Parameres and basal lobe, (D) Penis, Body size : Length 1.5- 1.7 mm; Width 0.8- 1 mm (n = 5)**.**

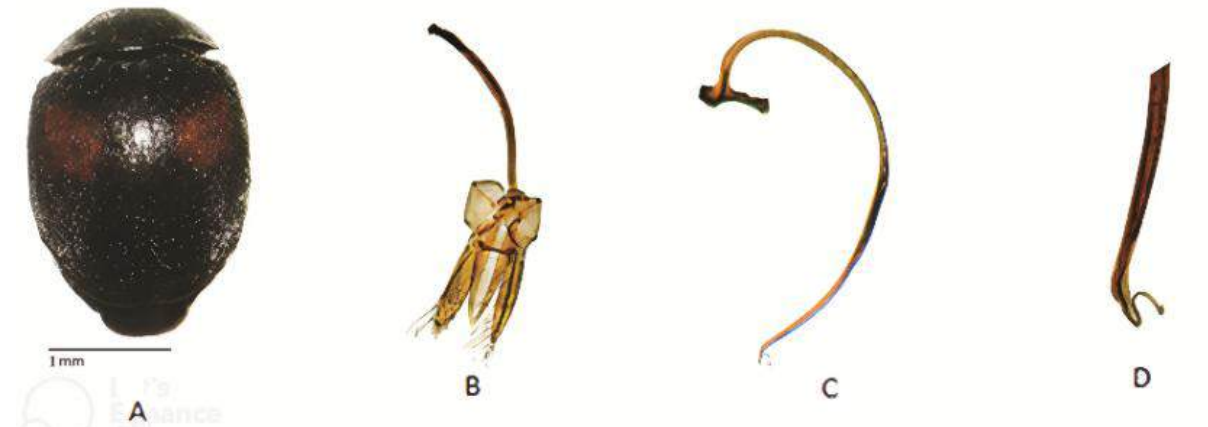

Figure 20. *Scymnus apetzi*, (A) Dorsal view of female, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size : Length 2.5- 3 mm; Width 1.8- 2.3 mm (n = 5)**.**

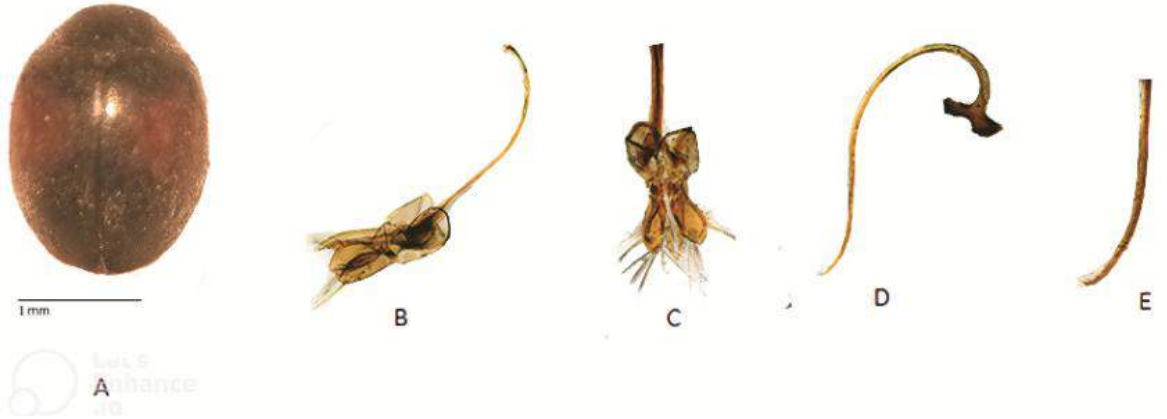

FIGURE 21. *Scymnus flavicollis*: (A) Dorsal view, (B) Lateral sides of tegmen, (C) Ventral view of tegmen, (D) Penis, (E) Tip of penis. Body size : Length 1.8- 2.5 mm; Width 1.3- 1.7 mm (n = 5).

Genus *Scymnus* Kugelann, 1794

***Scymnus apetzi* Mulsant, 1846**
(Figures 20, 29D)

Notes: *Scymnus apetzi* (Figs. 20, 29D) is reported for the first time from Kermanshah province. This species was collected manually and directly from pistachio trees infested with galling aphids and psylla, *A. pistaciae* and also this species collected from Pistachio in Kerman (Salehi *et al*., 2011). Furthermore, it was collected from Euphorbiaceae and Asteraceae plants infested with aphids and mealybugs.

Material studied: Kermanshah (Taq-e-Bostan mountains), *Pistacia mutica*, 12 adults (3 ♂, 9♀), 29.Aug.2020, Hadis Nehrangi; (Agricultural College), *Pistacia vera*, 6 adults (2 ♂, 4♀), 16.Aug.2021, Hadis Nehrangi; Gahvareh (Ghaleh-Ghazi village); *Euphorbia* sp. (Euphorbiaceae), *Cirsium vulgare* and *Centaurea* sp. (Asteraceae), 60 adults (25♂, 35♀) 6.May.2020, 13.May.2020, 25.Jul.2020, 19.Aug.2020, 8.Jul.2021, 3.Aug.2021, Abedin Safari.

Regional distribution in Iran: Alborz, Golestan, North Khorasan, Tehran (Abdolahi *et al*., 2017), West Azerbaijan (Parvizi *et al*., 1987), Fars (Yazdani, 1990), Chaharmahal and Bakhtiari (Bagheri & Mosadegh, 1995), Lorestan (Mohammad poor *et al*., 2013), Hamedan (Akhavan *et al*., 2013 and Abdolahi *et al*., 2017).

Worldwide distribution: Palearctic (Kovar, 2007).

***Scymnus flavicollis* (Redtenbacher, 1843)**
(Figures 21, 29A)

Syn.: *Scymnus triangulifer* Fleischer 1900
Scymnus araxicola Fleischer 1900
Scymnus rufithorax Baudi 1894.

Notes: *Scymnus flavicollis* (Figs. 21, 29A) is reported for the first time from Kermanshah province. This species was collected manually from pistachio trees infested by galling aphids and psylla, *A. pistaciae* and also collected from Pistachio in Kerman (Salehi *et al*., 2011). This species show a sexual dimorphism. Male with brown pronotum margin, but female having black pronotum.

Material studied: Kermanshah (Taq-e-Bostan mountains), *Pistacia mutica*, 6 adults (6♀), 29.Aug.2020, Hadis Nehrangi; *Medicago sativa* (Fabaceae), 28 adults (10♂, 18♀), 2.Jun.2021, 17.Jul.2021, Abedin Safari; Gehvareh, *Euphorbia* sp. (Euphorbiaceae), 45 adults (13♂, 32♀), 13.May.2020, 17.May.2020, 14.Jul.2020, 8.Sep.2020, 13.Aug.2021, Abedin Safari; Biston, *Medicago sativa* (Fabaceae), 29 adults (12♂, 17♀), 19.Sep.2021, 27.Sep.2021, Abedin Safari; Sahneh, *Medicago sativa* (Fabaceae), 33 adults (10♂, 23♀), 19.Sep.2021, Abedin Safari.

Regional distribution in Iran: Fars (Yazdani, 1990), Chaharmahal and Bakhtiari (Bagheri & Mosadegh, 1995), Isfahan (Haghshenas *et al*., 2004), Gilan (Hajizadeh *et al*., 2001), Lorestan (Mohammad poor *et al*., 2013), Semnan (Toozandejani and Ajamhassani, 2021).

Worldwide distribution: Algeria, France, Italy, Morocco, Tunisia (Kovar, 2007), Iran (Fursch, 1977), Syria (Mader, 1955), Lebanon (Fursch, 1977).

***Scymnus pharaonis* (Motschulsky, 1851)**
(Figures 22, 29C)

Syn.: *Scymnus araraticus* Lablokoff-Khnzorian, 1969

Notes: *Scymnus pharaonis* (Figs. 22, 29C) was collected from host trees infested by mites, It was reported by Fürsch (1997) from Kermanshah.

Material studied: Iran: Gahvareh, *Astragalus* sp. (Fabaceae), *Ficus carica* (Moraceae), 51 adults (18♂, 43♀), 9.Jun.2020, 12.Jun.2020, 31.Jul.2021, 16.Oct.2021, Abedin Safari; Kermanshah, *Populus* sp. (Salicaceae), *Juglans* sp. (Juglandaceae), 75 adults (23♂, 52♀), 19.Sep.2021, 23.Sept.2020, 27.Sep.2021, 30 Sep.2021, Abedin Safari; Islamabad-e-Gharb, Prunus *amygdalus* (Rosaceae), *Prunus armeniaca* (Rosaceae), 40 adults (10♂, 30♀), 9.Aug.2021, 17.Aug.2021,5.Oct.2021, Abedin Safari; Sahneh, *Malus domestica* (Rosaceae), 34 adults (9♂, 25♀), 15.July.2021, 28.Sept.2021, Abedin Safari.

Notes: Samples were strongly female-biased, which suggests a presence of male killing bacteria in the populations.

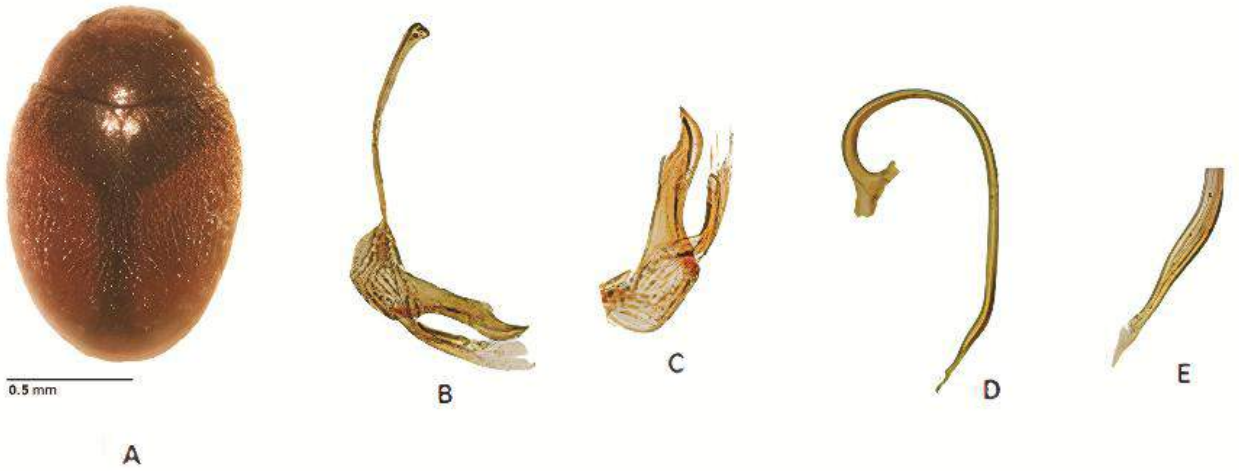

FIGURE 22. *Scymnus pharaonis*, (A) Dorsal view, (B) Tegmen, (C) Parameres and basal lobe, (D) Penis, (E) Tip of penis, Body size : Length 1.3- 1.5 mm; Width 0.9- 1.2 mm (n = 5).

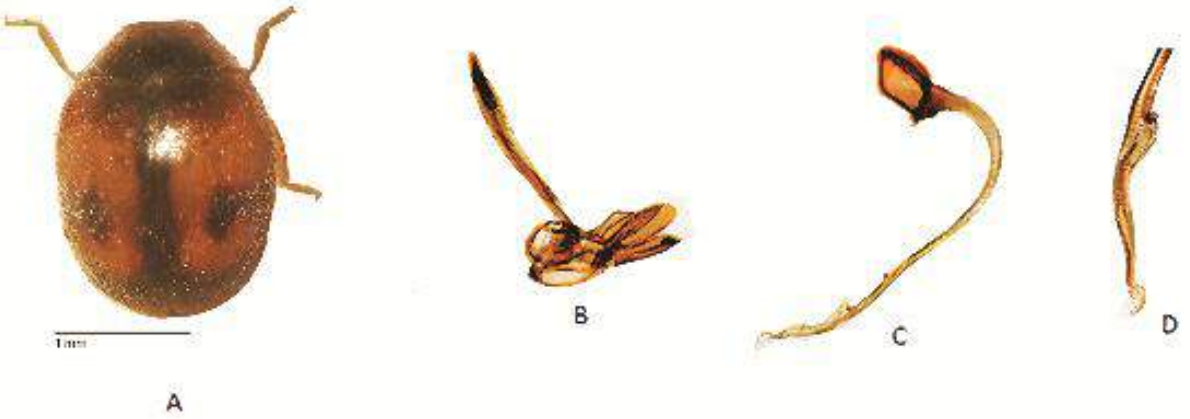

FIGURE 23. *Scymnus rubromaculatus*, (A) Dorsal view, (B) Ventral view of tegmen, (C) Lateral sides of tegmen, (D Penis, (E) Tip of penis, Body size: Length 1.9- 2.5 mm; Width 1.4- 1.8 mm (n = 5).

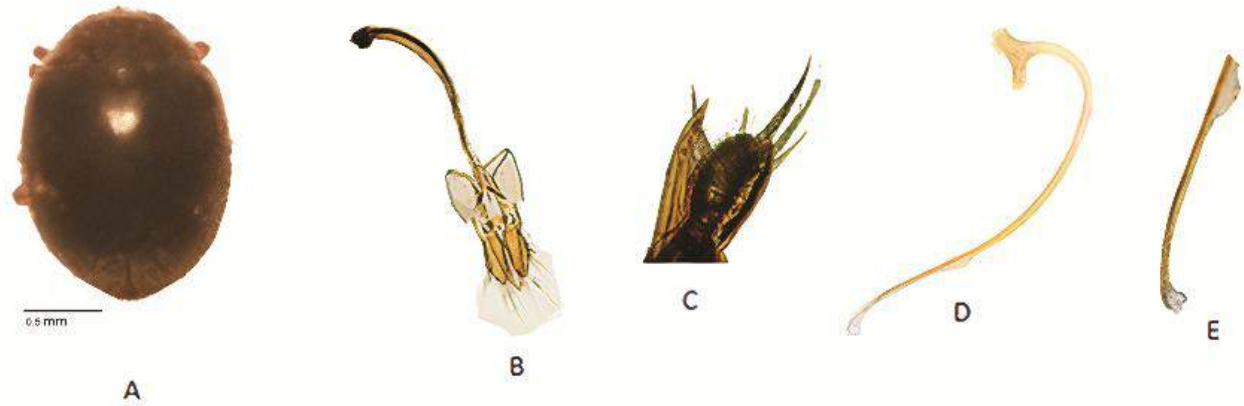

FIGURE 24. *Scymnus subvillosus*, (A) Dorsal view, (B) Tegmen, (C) Penis, (D) Tip of penis, Body size: Length 1.6- 2.3 mm; Width 1.2- 1.8 mm (n = 5).

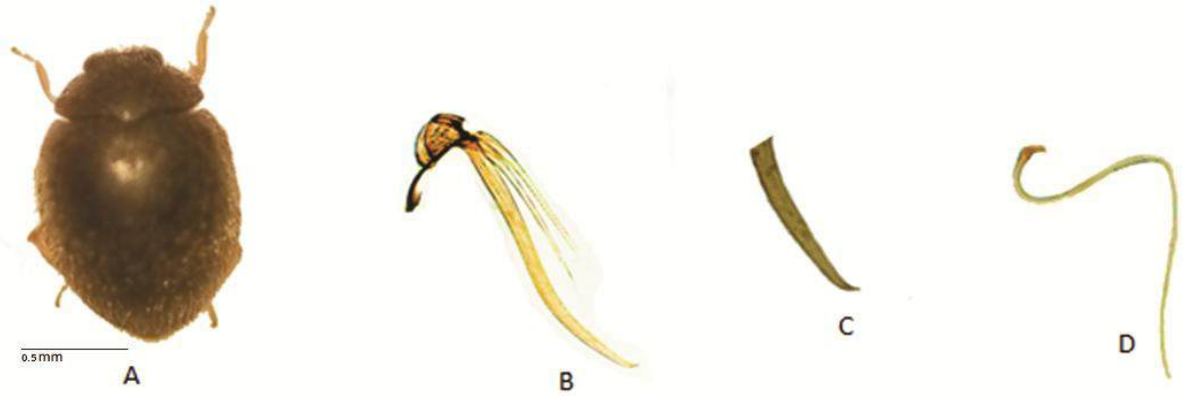

FIGURE 25. *Stethorus gilvifrons*: (A) Dorsal view, (B) Tegmen, (C) Basal lobe, (D) Penis, Body size : Length 1.3- 1.5 mm; Width 0.8- 1 mm (n = 5)**.**

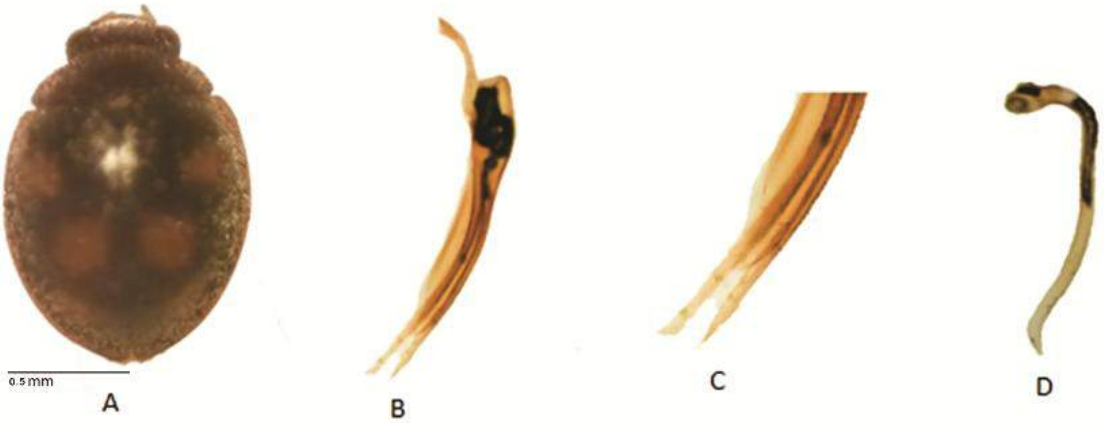

FIGURE 26. *Pharoscymnus pharoides*, (A) Dorsal view, (B) Tegmen, (C) Parameres and basal lobe, (D) Penis. Body size : Length 1.4- 1.6 mm; Width 0.9- 1.1 mm (n = 2)**.**

Regional distribution: Iran: Kerman (Kouhpayezadeh-esfahani & Mosadegh, 1991), Kermanshah (Fürsch, 1997), Fars (Yazdani, 1990), Chahar Mahal Bakhtiari (Bagheri & Mosadegh, 1995), Guilan (Hajizadeh *et al*., 1998), Lorestan (Mohammad poor *et al*., 2013).
Worldwide distribution: Palearctic: Armenia, Egypt, France, Germany, Iraq, Jordan, Turkey (Kovar, 2007), Iran (Fürsch, 1977; Kovar, 2007), Lebanon (Fürsch, 1977).

***Scymnus rubromaculatus* (Goeze, 1777)**
(Figures 23, 28I)
Syn.: *Coccinella rubromaculata* Goeze, 1777
Notes: *Scymnus rubromaculatus* (Figs. 23, 28I) is sexually dimorphic, males has a red margin of the pronotum, females have a black pronotum and head.
Material studied: Kermanshah; *Convolvulus* sp. (Convolvulaceae), *Medicago sativa* (Fabaceae), 125 adults (40♂, 85♀), 12.May.2021, 4.Jun.2021, 22.Jun.2021, 2.Jul.2021, 9.Jul.2021, Abedin Safari.
Regional distribution: Iran: Fars (Yazdani, 1990), Golestan (Abdolahi *et al*., 2017), Hamadan, Hormozgan, Golestan and Zanjan (Abdolahi *et al*., 2017) and Lorestan (Mohammad poor *et al*., 2013).
Worldwide distribution: Western Palearctic (Kovar, 2007); Afrotropical (Kovar, 2007).

Scymnus subvillosus* (Goeze, 1777)
(Figures 24, 29B)
Syn.: *Coccinella subvillosus* Goeze, 1777;
Pullus subvillosus (Goeze, 1777) in Kapur, 1959

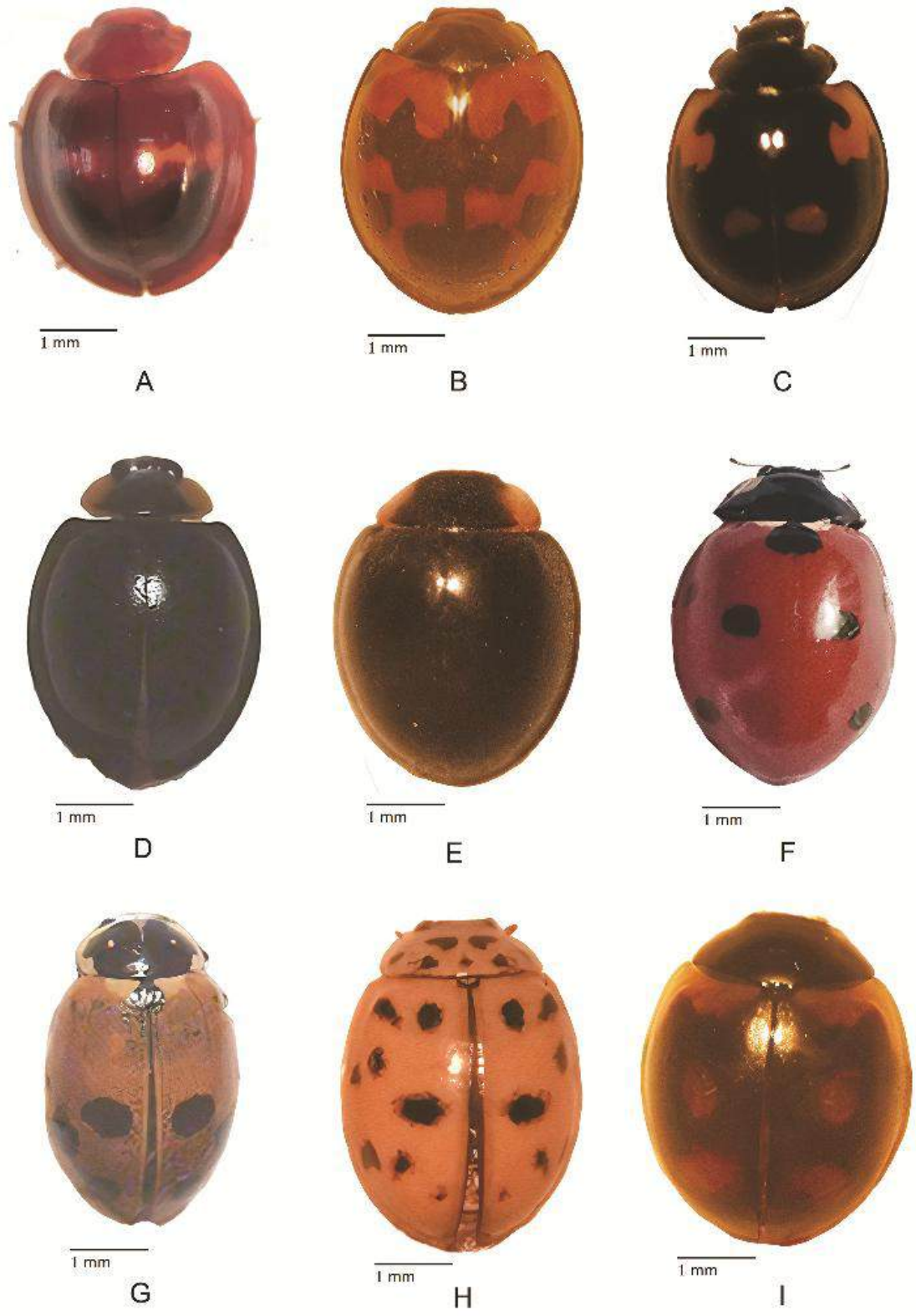

FIGURE 27. A: *Chilocorus bipustulatus*, B: *Exochomus undulatus*, C: *Exochomus quadripustulatus*, D: *Parexochomus nigromaculatus*, E: *Parexochomus pubescens*, F: *Coccinella septempunctata*, G: *Hippodamia variegata*, H: *Oenopia conglobata*, I: *Oenopia oncina*.

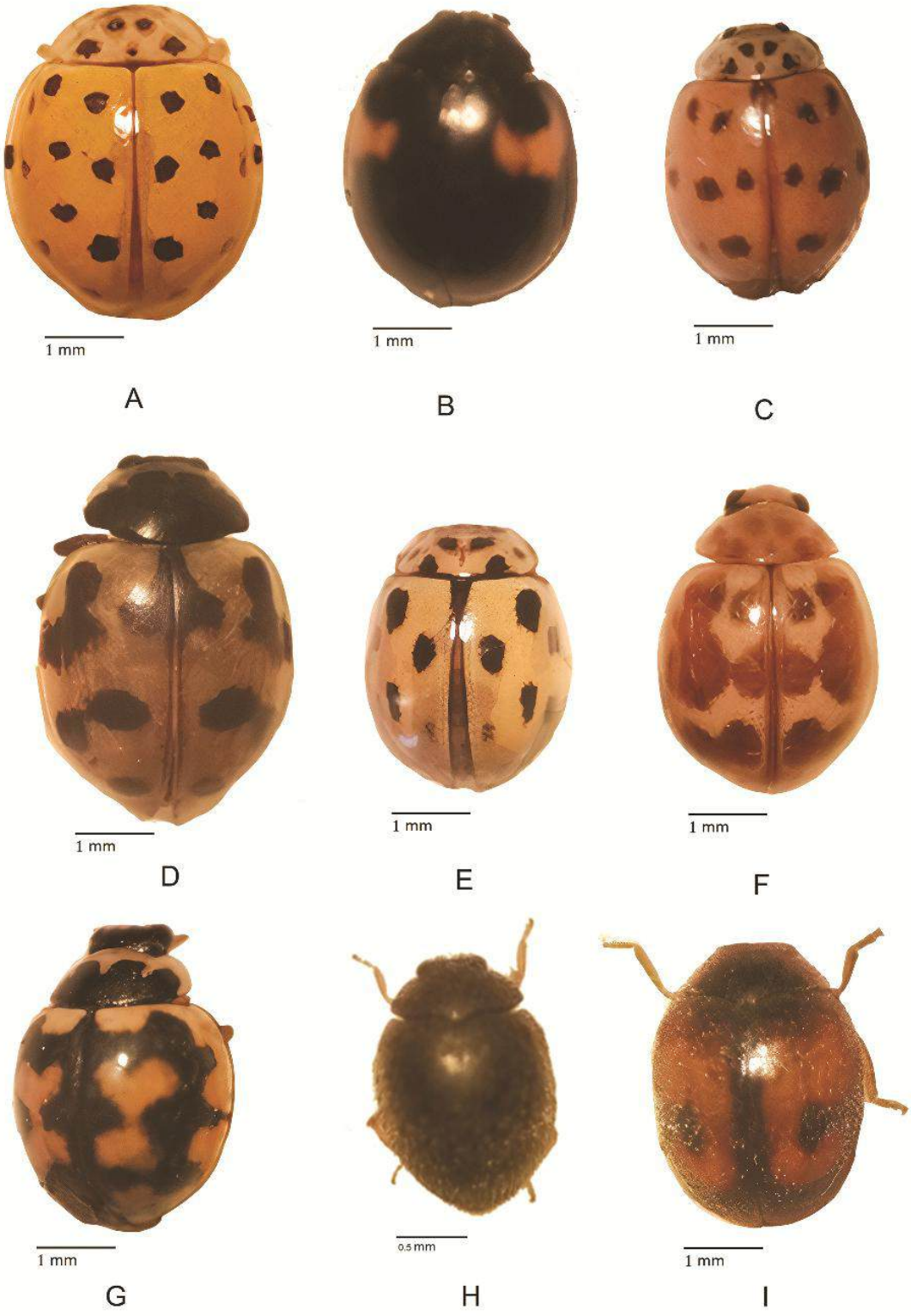

FIGURE 28. A: *Psyllobora vigintiduopunctata*, B: *Adalia decempunctata*, C: *Adalia bipunctata*, D: *Hippodamia undecimnotata*, E: *Propylea quatuordecimpunctata*, F: *Coccinula elegantula*, G: *Coccinula redimita*, H: *Stethorus gilvifrons*, I: *Scymnus rubromaculatus*.

Notes: *Scymnus subvillosus* (Figs. 24, 29B) is reported for the first time from Kermanshah province. This species was collected manually, from Pistachio trees infested by galling aphids and psylla, *A. pistaciae*. Also before reported on Pistachio in Kerman (Salehi *et al*., 2011). Besides those plants, it was collected from peach trees and okra (*Abelmoschus esculentus* Linnaeus) field infested by aphids. *Scymnus subvillosus* is sexually dimorphic, the males have a light brown head while, female have a black brown head.
Material studied: Kermanshah (Agricultural College), *Pistacia vera*, 6 adults (3 ♂, 3♀), 16.Aug.2021, Hadis Nehrangi; *Abelmoschus esculentus* (Malvaceae), 31 adults (8♂, 23♀), 15.Sep.2021, 17.Sep.2021, Abedin Safari. Gehvareh, *Prunus persica* (Rosaceae), 34 adults (12♂, 22♀), 22.May.2020, 25.May.2020, 1.Jul.2020, 5Jul..2020, 15.Jul.2021, Abedin Safari.
Regional distribution: Iran: Alborz and Sistan and Baluchistan (Abdolahi *et al*., 2017), Kerman (Kouhpayezad- Ehesfahani & Mosadegh, 1991), Fars (Yazdani, 1990), Mazandaran (Pahlavani *et al*., 2017), Lorestan (Mohammad poor *et al*., 2013), Semnan (Toozandejani and Ajamhassani, 2021).
Worldwide distribution: Palearctic, Iran (Kovar, 2007); Afrotropical (Kovar, 2007)

Genus *Stethorus* Weise, 1885

***Stethorus gilvifrons* (Mulsant, 1850)**
(Figures 25, 28H)
Syn.: *Scymnus* (*Pullus*) *gilvifrons* Mulsant, 1850
Notes: The ladybird, *Stethorus gilvifrons* (Figs. 25, 28H) was collected from the trunks of pistachio trees that were affected by mite infestations (the common pistachio mite, *Tenuipalpus granati* Sayed (Acari, Tenuipalpidae). The majority of the mites, along with their eggs and nymphs, were found in the fissures and crevices of the tree bark. Previously, this species reported by Gholami Moghadam *et al*., (2014) from Kermanshah.
Material studied: Kermanshah (Taq-e-Bostan mountains), *Pistacia mutica*, 4 adults (1 ♂, 3♀), 21.Jul.2020, Hadis Nehrangi; *Juglans* sp. (Juglandaceae), *Cupressus* sp. (Cupressaceae), *Populus* sp. (Salicaceae), 48 adults (13♂, 35♀), 29.Apr.2021, 31.Apr.2021, 6.May.2021, Abedin Safari; Islamabad-e-Gharb, *Prunus persica*, *Prunus amygdalus* and *Malus domestica* (Rosaceae), 37 adults (10♂, 27♀), 24.May.2020, 3.Jun.2020, 12.Jun.2020, 12.Jul.2021, Abedin Safari; Dalaho, *Prunus amygdalus* and *Malus domestica* (Rosaceae), 83 adults (30♂, 53♀), 12.Aug.2020, 29.Sep.2020, 4.Oct.2020, 18.Oct.2020, 26.Oct.2021, Abedin Safari; Gilan-Gharb, *Malus domestica* (Rosaceae), 22 adults (7♂, 15♀), 6.Apr.2021, 8.Apr.2021, Abedin Safari.
Notes: Samples were female-biased, which suggests a presence of male killing bacteria in the populations, which was not previously reported in this genus.
Regional distribution in Iran: Kermanshah (Gholami Moghadam *et. al*. 2014), Fars (Yazdani, 1990), Gilan and Golestan (Montazeri & Mosadegh, 1995), Chaharmahal Bakhtiari (Bagheri & Mosadegh, 1995), Ardabil (Razmjo & Hajizadeh, 2000), Isfahan (Haghshenas *et al*., 2004). Mazandaran (Pahlavani *et al*., 2017), Lorestan (Mohammad poor *et al*., 2013), Hamadan (Eghbalian *et al*., 2008) and Yazd (Zare *et a*l., 2014),
Worldwide distribution: Palearctic: Afghanistan, Armenia, Azerbaijan, Bulgaria, Croatia, Cyprus, Egypt, France, Greece, Iran, Iraq, Italy, Lebanon, (Kovar, 2007), Pakistan (Ashfaque, 2012), Turkey (Efil et al., 2010), Saudi Arabia (Raimundo & Van Harten, 2000).

Tribe STICHOLOTIDINI
Genus *Pharoscymnus* Bedel, 1906

***Pharoscymnus pharoides* Marsuel, 1868**
(Figures 26, 29H)
Notes: *Pharoscymnus pharoides* (Figs. 26 and 29H) was collected with a beating tray. This ladybird was previously reported by Jalilvand *et al* (2014) from Kermanshah province.

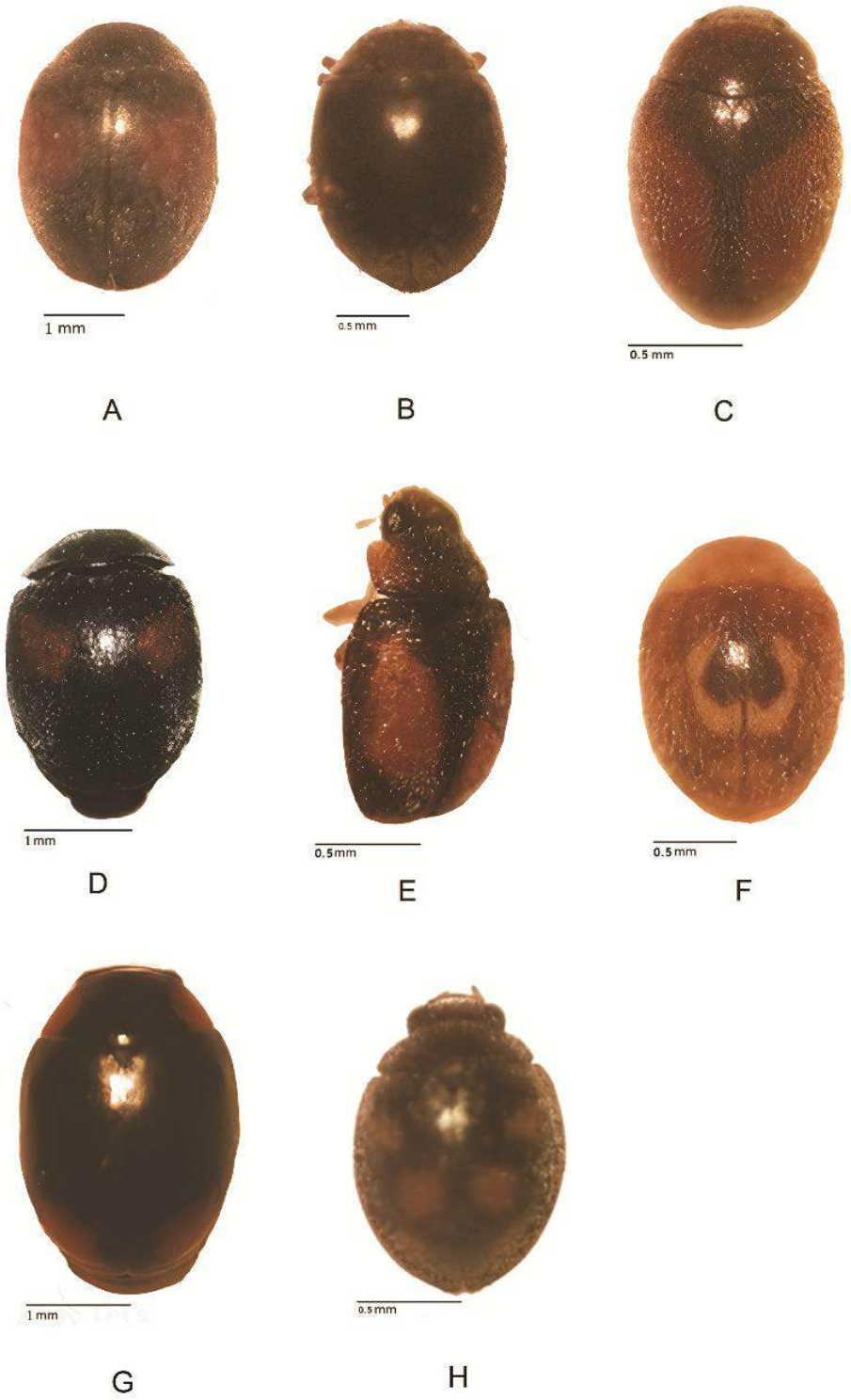

FIGURE 29. A: *Scymnus flavicollis*, B: *Scymnus subvillosus*, C: *Scymnus pharaonis*, D: *Scymnus apetzi*, E: *Diomus rubidus*, F: *Clitostethus arcuatus*, G: *Hyperaspis pseudopustulata*, H: *Pharoscymnus pharoides*.

Material studied: Iran: Kermanshah, *Fraxinus excelsior* (Oleacae), 1 Adult (1♀), 25 Jun 2020, Abedin Safari; Gehvareh, *Prunus amygdalus* (Rosaceae), 1 adult (1♂) 18.Aug.2022, Abedin Safari; infested by mites.
Regional distribution: Iran: Chahar Mahal Bakhtiari (Bagheri & Mossadegh, 1995) and Kermanshah (Jalilvand *et al*., 2014).
Worldwide distribution: Palearctic: Egypt, Israel, Syria, Libya, Saudi Arabia, Turkey, Iran; Afrotropical (Kovar, 2007).

DISCUSSION

According to the results, *Coccinella septempunctata* L.,1758 on *Medicago sativa*, *Hippodamia variegata* (Goeze, 1777) on *Carthamus* sp. and *Oenopia conglobata* (Linnaeus, 1758) on *Prunus persica* all occur in large numbers throughout the region and are likely to be biologically important. These three species were also collected from pistachio trees infested by members of Sternorrhyncha. Below, the focus of our discussion is on ladybird, *Coccinella septempunctata*, from which we will extend our discussion to cover two other ladybird species.

As we said, *Coccinella septempunctata*, in alfalfa field, *Medicago sativa*, which infested with Aphids is present in large numbers throughout the region. This ladybug is biologically important. It can be said that planting a row of alfalfa in the pistachio orchard can attract the ladybird, *C. septempunctata* , in the pistachio orchard. Since this ladybug is a polyphagous predator, its attraction and distribution in the garden can play an effective role in reducing pistachio pests.

ACKNOWLEDGMENTS

This study combines findings from two thesis conducted at Razi University. The undergraduate students involved demonstrated considerable diligence despite facing constraints in resources and budget. The practical outcomes achieved are noteworthy. The findings presented in this article have the potential to contribute to a decrease in the use of chemical pesticides and to enhance biological control methods in pistachio orchards. The contributions and dedication demonstrated by both students are praiseworthy.

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REVIEW ARTICLE Open access

Systematics and distribution of the true monitors *Varanus* Merrem, 1820 (Sauria, Varanidae) on the Iranian Plateau

Narges Ghanbarinia, Rasoul Karamiani*, Ahmad Gharzi, & Nasrullah Rastegar-Pouyani

Department of Biology, Faculty of Science, Razi University, 6714967346 Kermanshah, Iran.

Abstract
Varanoidea is an ancient group of anguimorph lizards, the anguimorph genus *Varanus* includes today's monitor lizards, a clade of mid-sized to large, squamates widely distributed in tropical and subtropical regions. biogeographic analysis suggests an origin of varaniform lizards in East Asia. According to most studies, monitors grouped in three clades concordant with their geographic distribution: African, Indo-Asian, and Indo-Australian. There are currently 88 valid species assigned to *Varanus* that divided into 11 subgenera. In the Iranian Plateau, there are four species of monitors from two subgenera *Psammosaurus* including *Varanus griseus*, *Varanus caspius*, *Varanus nesterovi* and *Empagusia* include the species *Varanus bengalensis. V. caspius* is mostly present in the central parts of Iran, two species *V. griseus* and *V. nesterovi* being distributed from Kermanshah province to Shiraz and also in Iraq. The end of distribution of the species *V. bengalensis* is in the southeast of Iran including Sistan-Baluchestan and Hormozgan Provinces.

Key words: *Varanus*, monitor, Varanidae, Distribution, Iranian plateau, Asia.

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INTRODUCTION

Varanoidea is an ancient group of anguimorph lizards, comprising two extant New World helodermatids (*Heloderma horridum* and *Heloderma suspectum*), the Bornean earless monitor (*Lanthanotus borneensis*), and the Old-World monitors (*Varanus*) (Ast, 2001). The anguimorph genus *Varanus* encompasses today's monitor lizards (Varanidae Hardwicke & Gray, 1827), a clade of mid-sized to large, mostly carnivorous (though some are frugivorous) squamates widely distributed in tropical and subtropical regions (Fig. 1; Ivanov et al., 2017). In animals, body size dramatically affects life-history traits and ecology, and it is the most commonly used measurement in macroevolutionary studies (Wilson, 1975). Among terrestrial vertebrates, monitor lizards (*Varanus*) exhibit the greatest variation in body size within a single terrestrial vertebrate genus (Pianka, 1995). Extant monitors include island giants like the Komodo dragon (*V. komodoensis*) (up to 3 m long and 100 kg) and desert dwarves like the short-tailed goanna (*V. brevicauda*) (0.2 m and 0.016 kg), which vary by orders of magnitude (Brennan et al., 2021). Despite a conservative body plan, monitor lizards in Africa, Asia, and Australia are ecologically diverse. They also show specific ecological and morphological adaptations and can be found at home in trees, among rocks, in burrows, and swimming through watercourses and even the open ocean (Pianka, 1995; Bucklitsch et al., 2016). Monitor lizards inhabit a variety of environments, from deserts to rainforests (Bucklitsch et al., 2016). Most varanids are moderate to large in size with thick skin containing numerous rows of small, rounded scales circling the body. Monitors have well-developed limbs; their tail is long to very long and lacks caudal autotomy (Vitt & Caldwell, 2013). The greatest morphological diversity is

*Corresponding Author: ✉ : r.karamiani@razi.ac.ir

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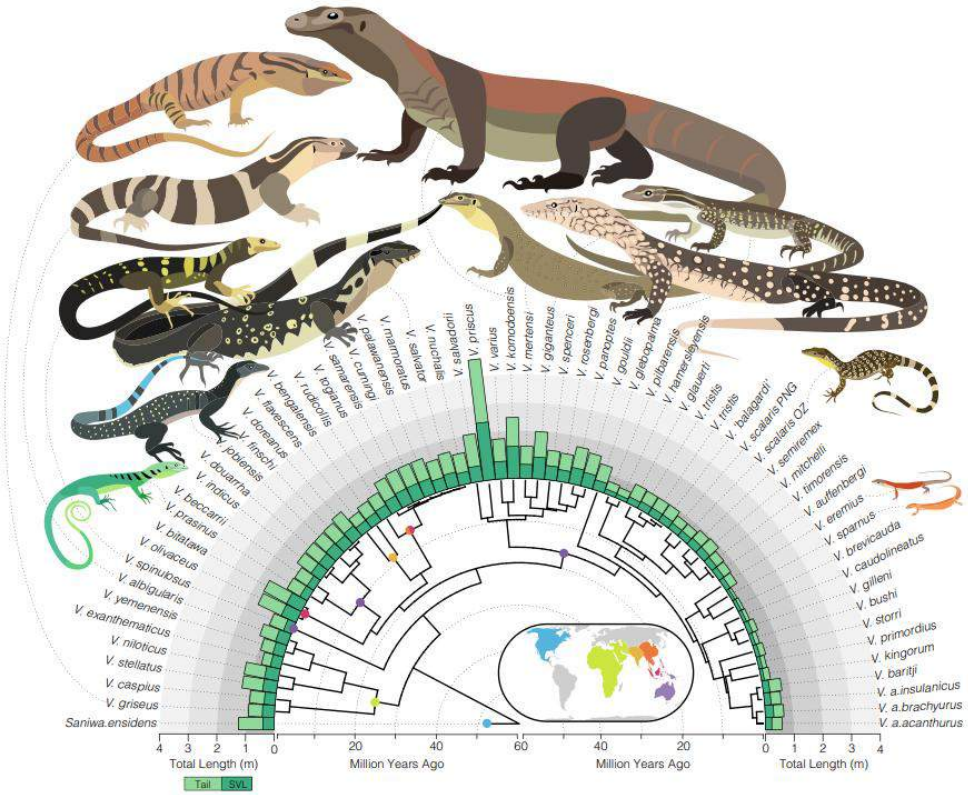

FIGURE 1. Body size among *Varanus* species varies across multiple orders of magnitude. Bar plots at tips of the tree show total length of sampled monitor lizards broken down into snout-vent length (SVL) and tail length. Inset map shows a rough global distribution of monitor lizards and the extinct relative Saniwa ensidens. Colored circles at nodes indicate primary distribution of the major clades of *Varanus* and correspond to distributions on the map (blue–North America; green–Africa and the Middle East; light orange–Indian Subcontinent; dark orange–Indochina and China; red–Sundaland and Wallacea; purple–AustraloPapua. (Brennan et al., 2021).

concentrated in the Australian species (Brennan et al., 2021). he social structure of monitors is very complex, diverse, and non-stereotyped. Additionally, the presence of a mammal-like social structure in their populations has been confirmed (Tsellarius & Tsellarius, 1997). The methods of hunting different types of prey, changes in diet composition, and hunting behavior of *V. griseus* vary in relation to environmental conditions. *V. griseus* prefers to hunt relatively large prey that is concentrated in specific places with a specific spatial and temporal order. The most important feature for prey is the ability to find it with the least cost and energy. The most suitable types of prey are rodents (*Rhombomys opimus*) in sandy deserts, *Vipera lebetina*, and the nests of some birds in river valleys (Tsellarius et al., 1997). Lizards and arthropods are readily eaten, but their predation was recorded only in conditions of low rodent and/or snake abundance. Severe deterioration of feeding conditions leads to increased mobility of *V. griseus*, spatial redistribution, and, as a possible consequence, community fragmentation (Tsellarius et al., 1997). Global biogeographic analysis of *Varanus* and allies suggests an East Asian origin for varaniform lizards, with dispersals west across Laurasia into Europe and east into North America. The origin of the genus *Varanus* is equivocal, but it likely followed a similar pattern, with independent clades dispersing west through the Middle East and into Africa and Europe, and south and east through Southeast Asia, Sundaland, and into IndoAustralia (Brennan et al., 2021). Monitor lizards have a fossil record dating back to the Late Cretaceous (Ivanov et al., 2017), and several varanoid lizards have been described from the Late Cretaceous and Tertiary periods (Holmes et al., 2010).

Currently, no extant monitor lizard species are known from European territory, as geographically defined by an eastern border following the Ural Mountains and the Ural River, through the Caspian Sea to the eastern end of the main chain of the Great Caucasus, from which it runs westwards to the Black Sea. From there, it continues through the Bosporus, the Marmara Sea, and the Dardanelles towards the Aegean Sea, where the islands on the Anatolian shelf are excluded (Mertens and Wermuth, 1960). However, fossil representatives of this family were present in Europe until the Middle Pleistocene (Georgalis et al., 2017; Böhme et al., 2023).The fossil record of Varanidae, although still very incomplete, demonstrates great diversity across most of the Cenozoic and a wide geographic distribution. This encompasses broad areas that are currently well outside the range of extant forms, such as North America and Europe (Georgalis et al., 2021; Molnar, 2004). In fact, the varanid fossil record is far richer in Europe than on any other continent, spanning from the earliest Eocene up to the Middle Pleistocene (Augé, 2005; Augé et al., 2022; Fejérváry, 1935; Georgalis et al., 2017; Hofstetter, 1969; Villa et al, 2018; Georgalis et al., 2023). Most studies use these fossils and molecular data to determine interspecific relationships (Arida & Böhme, 2010). Several varanid paleospecies have been described from European and neighboring fossil sites. Those described before Estes (1983) were already synonymized by this author with *V. marathonensis* (Villa et al., 2018). The latter authors recognized only two European paleospecies, namely *V. marathonensis* and *V. mokrensis*. This seems problematic as long as only osteological characters are available (Böhme et al., 2023). The mitochondrial phylogeny by Ast (2001) is probably the most comprehensive and reliable study inferring relationships among extant varanid lizards because it is well sampled across taxonomic classification and geographic distribution (Arida & Böhme, 2010). In this phylogeny, extant species are grouped into three clades concordant with their geographic distribution: African, Indo-Asian, and Indo-Australian (Villa et al., 2018).

Given the phylogenetic hypothesis of Conrad (2012), no fewer than eight major *Varanus* lineages must have been present. These radiations include groups of Indo-Asian A monitors (the *Empagusia*, *Indovaranus*, and *Tectovaranus* clades), the *Dendrovaranus-Soterosaurus* clade, the Australasian clade, the Indo-Asian B clade, the lineage including *Varanus griseus*, and the *Polydaedalus* clade (Conrad et al., 2012). Relationships among anguimorph lizard groups have been contentious, particularly with regard to the placement of fossil taxa (Conrad, 2008; Conrad et al., 2011; Pyron, 2017). Analysis of morphological data in concert with novel phylogenomic data are largely consistent with previous assessments; however, Brennan et al. (2021) provide new insights into the phylogenetics of living members of *Varanus*. This phylogeny of *Varanus* highlights the adaptive capacity of these amazing lizards, emphasizing their ability to fill available niches. Overall, Brennan et al. (2021) suggest a more recent timeline for the diversification of modern varanid lizards when compared to other phylogenetic studies, with a crown age in the early-to-mid Oligocene. This timing suggests *Varanus* potentially dispersed into the Indo-Australian region shortly after the collision of the Australian and Asian plates. If this is true, the connection of Sahul to Sundaland likely facilitated the dispersal of monitor lizards across an Indonesian island bridge, and extensive overwater dispersal seems less probable. This pattern is consistent with the adaptive radiation of Australopapuan elapid snakes (Keogh, 1998) and python snakes (Reynolds et al., 2014; Esquerre et al., 2019), from Asian origins (Fig. 1; Brennan et al., 2021). The most recent study on the phylogenetic relationships of varanids was carried out by Georgalis et al. (2023) after the discovery of two fossil teeth from the Early Miocene of Hüenerbach, Switzerland. In this study, to obtain the optimal tree, they performed parsimony-based character optimization on denticles based on the phylogeny of Pyron et al. (2013) (Fig. 2; Georgalis et al., 2023). Levshakova (1986) and Stanner (2004) considered *Psammosaurus* to be composed of three species, namely the extant *V. griseus* and the two fossil taxa *V. darevskii* and *V. marathonensis*. Ivanov et al. (2018), as well as Villa et al. (2018), in contrast, assigned the last-named species to the Indian clade where *V. bengalensis* is also accommodated (the *Empagusia* group of *Varanus*). *Varanus darevskii* from the Pliocene of Tadzhikistan, however, is still regarded as a close relative or even predecessor of the extant desert monitors, and, particularly, on biogeographical grounds, of *V. caspius*. Thus, the SW Asian origin of the *Psammosaurus* clade is made plausible by

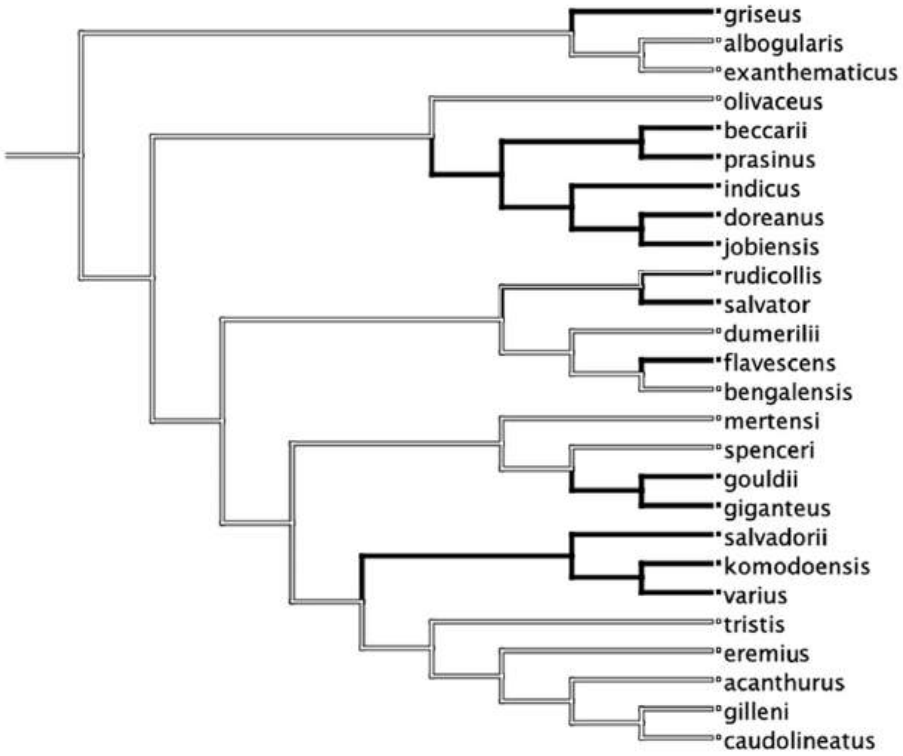

FIGURE 2. Parsimony-based character optimization on the tooth serrations based on the phylogeny of Pyron et al. (2013) (Georgalis et al, 2023*)*

V. darevskii, the extinct predecessor and Pliocene ancestor of *V. caspius* (Levchakova, 1986) from Tadzhikistan. Apart from the distinct morphological differences between the nominal taxa *V. griseus*, *V. nesterovi*, and *V.caspius* (shape of nostril, neck scalation, dorsal color pattern, tail shape, and tail coloration), the chorological pattern of the three parapatric forms also supports their full specific rather than subspecific status (Böhme et al., 2023).

SYSTEMATICS ACCOUNT

Order Squamata Oppel, 1811
Superfamily Varanoidea Camp, 1923
Family Varanidae Gray, 1827

Genus *Varanus* Merrem, 1820

There are currently 88 valid species assigned to *Varanus* (Uetz et al., 2024). This genus is divided into 11 subgenera, eight of which are represented in the Pacific East. Of these, one (*Philippinosaurus*) occurs only in the Philippines, one (*Soterosaurus*) is primarily found west of Weber's Line, and five (*Euprepiosaurus*, *Hapterosaurus*, *Odatria*, *Papusaurus*, *Varanus*) are restricted to Australia, New Guinea, and some of the Lesser Sunda Islands. The monotypic subgenus *Solomonsaurus* is restricted to parts of the western Solomon Islands (McCoy, 2015; Weijola, 2017; Uetz et al., 2024). Other subgenera include *Psammosaurus*, *Polydaedalus*, and *Empagusia* (Böhme, 2003).

Subgenus *Soterosaurus* Ziegler & Böhme, 1997

Distribution: From Sri Lanka through continental and insular Southeast Asia including the Philippines as well as the Greater and Lesser Sunda Islands, Sulawesi, and the northern Moluccas (Koch et al., 2013).

Subgenus *Varanus* Merrem, 1820
Distribution: Australia, southern part of New Guinea, and some Lesser Sunda Islands (Koch et al., 2013).

Subgenus *Papusaurus* Mertens, 1962
Distribution: Restricted to New Guinea.
The monotypic subgenus *Papusaurus* contains only one species, *V. salvadorii* (Koch et al., 2013).

Subgenus *Odatria* Gray, 1838
Distribution: Australia, New Guinea, Timor and off-shore islands.
The subgenus Odatria of monitor lizards underwent a major radiation on the Australian. three members of this subgenus, i.e., *V. auffenbergi*, *V. similis*, and *V. timorensis*, inhabit islands of the IndoAustralian Archipelago (Koch et al., 2013).

Subgenus *Philippinosaurus* MERTENS, 1959
Distribution: Restricted to the Philippine islands of Luzon and Panay.
The subgenus *Philippinosaurus* comprises the only fructivorous monitor lizard species that feed mainly on leaves and fruits. All species are endemic to the Philippines (Koch et al., 2013).

Subgenus *Euprepiosaurus* Fitzinger, 1843
Distribution: Moluccas, New Guinea, Northern Australia, and various Pacific island groups such as the Bismarck Archipelago, the Solomons, and the Marshall Islands.
The subgenus *Euprepiosaurus* comprises two monophyletic clades, viz. the species groups of Pacific or Mangrove Monitors around V. indicus and the Tree Monitors around *V. prasinus* (Koch et al., 2013).

Subgenus *Hapterosaurus* Buckitsch, Bohme & Koch, 2016
Distribution. Members of the subgenus **Hapturosaurus** are restricted to the tropical rainforests of New Guinea and several offshore islands, such as Waigeo, Batanta, and the Aru Islands, as well as Northern Australia. During Pleistocene sea level depressions of up to 140 meters below present levels, all these island regions belonging to the Sahul Shelf were interconnected by subaerial land bridges (Voris, 2000; Bucklitsch et al., 2016).

Hapturosaurus is a monophyletic group (Ast, 2001; Ziegler et al., 2007) of medium-sized arboreal lizards (Collar et al., 2011) from New Guinea and northern Australia. This group was formerly placed as a species group within the subgenus *Euprepiosaurus*. The name *Hapturosaurus* refers to the autapomorphy of the prehensile tail found in the highly arboreal tree monitors of the V. prasinus species group (Bucklitsch et al., 2016).

Subgenus *Solomonsaurus* Buckitsch, Bohme & Koch, 2016
Distribution. The subgenus *Solomonsaurus* is endemic to the Solomon Islands southeast of New Guinea. it is known only from the islands of San Jorge (St. George), Santa Isabel, and Bougainville (Böhme & Ziegler 2007).
Originally, Mertens (1941) described *Varanus spinulosus* as a subspecies of the widespread *Varanus indicus*, based on his multiple species concept of Pacific monitors (Mertens, 1942). Later, the taxon was elevated to full species status by Sprackland (1994) and was initially placed in the subgenus *Euprepiosaurus* by Ziegler & Böhme (1997). However, *V. spinulosus* recently had to be removed from this subgenus because it lacks the unique synapomorphies of this monitor in genital morphology (Böhme & Ziegler, 2007). Therefore, the systematic position of this monitor lizard species was considered *incertae sedis* (Koch et al., 2010) and required review. In 2016, it was placed in the new subgenus ***Solomonsaurus***. The name *Solomonsaurus* refers to the Solomon Islands, which is the distribution range of the only recognized species within this currently monotypic subgenus (Bucklitsch et al., 2016).

Subgenus *Polydaedalus* Wagler, 1830
Distribution: the African steppe monitors (Bohme & Ziegler,1997).
The species of *Polydaedalus* mostly inhabit savannah habitats in Africa (Bucklitsch et al., 2016).

Subgenus *Empagusia* Gray, 1838
Distribution: From southeastern Iran and Afghanistan through Pakistan, India, Bangladesh and Nepal to Myanmar, Thailand, Malaysia, and the Greater Sunda Islands, Indonesia.
The subgenus *Empagusia* represents a paraphyletic clade (Koch et al., 2013).
Subgenus *Psammosaurus* Fitzinger, 1826
Distribution: northern Africa, Arabia, Middle East, Central Asia and southern Asia.
Species of the monotypic subgenus *Psammosaurus* are adapted to arid environments in Africa, Arabia, and southern Asia. This taxon is sister to the Polydaedalus clade in recent molecular phylogenies (Ast, 2001; Collar et al., 2011*).*

Manitors in the Iranian plateau
Varanus psammosaurus griseus (Daudin, 1803)
Tupinambis griseus Daudin 1803 (Type locality: Dardsha, coast of the Caspian Sea)
Varanus scincus Merrem 1820
Tupinambis arenarius Geoffroy 1827
Varanus arenarius Duméril & Bibron 1836
Monitor terrestris Calori 1857
Psammosaurus terrestris Rabl Rückhard 1881
Psammosaurus scincus Blanford 1881
Varanus griseus Boulenger 1885
Psammosaurus griseus Sixta 1900
Varanus (*Psammosaurus*) *griseus* Mertens 1942
Varanus griseus griseus Gardner 2013
Varanus griseus Šmíd et al. 2014
Varanus (*Psammosaurus*) *griseus* Bucklitsch et al. 2016
Varanus griseus Bar et al. 2021
Varanus griseus Böhme et al. 2023

The **desert monitor lizard** has a concave head and a nostril in the form of a diagonal slit that narrows anteriorly and is closer to the eye. It possesses relatively weakly enlarged glands on the neck, a dorsal side usually with dark and/or distinct cross-stripes, and lighter spots on the ground that are darker. Its tail is round in cross-section with distinct cross-stripes along its length (Fig. 3; Böhme, 2015). *Varanus griseus* (Daudin, 1803) is a terrestrial species with a desert-sandy distribution pattern whose population includes two subspecies: *V. g. griseus* in North Africa, Arabia, and the Near East, and *V. g. koniecznyi* Mertens, 1954 in southern Pakistan and northwestern India (Mertens, 1942, 1954; Böhme, 1997, 2003, 2015). The gray desert monitor is found in the Provinces of Khuzestan, Ilam, Kermanshah, Bushehr, and Fars (Fig. 7; Safaei Mahro et al., 2015).
The zoogeographical origin of Desert Monitor is Saharo-Turano-Sindian region (Anderson, 1999; Baig et al., 2008; Bauer et al., 2017; Bayless, 2002; Damadi et al., 2017;Escoriza et al., 2011; Jablonski et al., 2021; Khan, 2004; Mertens, 1954; Malakhov & Chirikova, 2018; Sindaco et al.,2000; Akman1 et l., 2023).

Varanus psammosaurus caspius (Eichwald, 1831)
Psammosaurus caspius Eichwald 1831 (Type locality: Dardsha Peninsula, southeastern coast of Caspian Sea, Turkmenistan).

FIGURE 3. *Varanus griseus*. The sample was found in the south of Dehloran city, Ilam province (Fathnia et al., 2009).

Varanus caspius Gray 1845
Varanus griseus caspius Anderson 1963
Varanus griseus caspius Nilson & Andren 1981
Varanus griseus caspius Khan 2003
Varanus griseus caspius Heidari et al. 2010
Varanus caspius Böhme et al. 2023
In 2023, Boehm et al. declared the *V. caspius* a separate species from the *V. griseus*, based on morphological differences, habitat, and distribution of Iranian plateau monitors and the results of the Brennan et al (2021) study (Fig. 4).

The following are some of the characteristics of the scaly fish: the anterior half of the tail is more or less circular in transverse section, narrow in the posterior half, compressed on both sides in transverse section, and has a distinct blade on the upper surface; the ventral scales are in 110-125 transverse rows from the collar to the groin; the transverse stripes on the dorsal area are red-brown; and the tail has 13-19 dark transverse stripes; the end of the tail (usually the distal third) is uniformly yellowish and patternless (Rastegar-Pouyani et al., 2007).

V. g. caspius (Eichwald, 1831) has a vast distribution from central Iran (Qom) and the eastern coast of the Caspian Sea in the west to Tadzhikistan in the east (Fig. 7; Ehrlich, 2013; Chirikova et al., 2019; Böhme, 2023).

Varanus empagusia bengalensis (Daudin, 1802)
Tupinambis bengalensis Daudin 1802
Tupinambis cepedianus Daudin 1802
Lacerta argus Daudin 1802
Varanus punctatus Merrem 1820
Varanus taraguira Merrem 1820
Varanus bengalensis Duméril & Bibron 1836
Monitor inornatus Schlegel 1839
Monitor cepedianus Schlegel 1839
Uaranus lunatus Gray 1845
Varanus dracaena Theobald 1868

FIGURE 4. *Varanus caspius*. The Zoological Museum specimen of Razi University has been used for photographing.

Varanus lunatus Anderson 1871
Varanus dracaena Anderson 1871
Varanus bengalensis Mertens 1942
Varanus (*Empagusia*) *bengalensis* Koch et al. 2013
Varanus (*Empagusia*) *bengalensis* Bucklitsch et al. 2016

The Bengal Monitor (*Varanus bengalensis*) can reach a snout-vent length (SVL) of around 180 cm, with a 100 cm tail. It's terrestrial in habit, though young individuals can be arboreal (Fig. 5; Kabir et al., 2009). This species is primarily omnivorous; however, scavenging is frequently observed. It's found in all habitats throughout Bangladesh. As a large and ecologically flexible species, *Varanus bengalensis* is commonly encountered in many ecological settings, including human-modified habitats. Its global distribution ranges from southeastern Iran to southern Asia (Jaman et al., 2024). In Iran, the Bengal Monitor, also sometimes called the Bengal Tiger, is present in the Provinces of Sistan and Baluchestan, Kerman, and Hormozgan (Fig. 7; Safaei-Mahroo et al., 2015).

Varanus psammosaurus nesterovi Böhme, Ehrlich, Milto, Orlov & Scholz, 2015
Varanus nesterovi Böhme, Ehrlich, Milto, Orlov & Scholz 2015 (Type locality: "Biare," currently Byara Village, Muhafazat as Sulaymaniyah, Iraq (35°13'50'' N 46°07'15'' E), 1086 m elevation)
Varanus griseus Tuck 1971
Varanus griseus caspius Mertens 1973
Varanus griseus caspius Fathinia et al. 2009
Varanus (*Psammosaurus*) *nesterovi* Bucklitsch et al. 2016
Varanus (*Psammosaurus*) *nesterovi* Böhme et al. 2023

Nesterov's desert monitor A large growing representative of the section *Psammosaurus Varanus* (total length up to 120 cm) easily distinguished from *V. griseus*, 1.its broad, short head with a convex profile. 2. nostrils round to vertically oval, not quite in front of the eyes. 3.scaly neck of strongly enlarged scales and spines, strongest on the sides of the neck, which may even form curved spines. 4.dorsal side uniformly sandy, without well-visible dark cross-stripes, at best with only rudimentary and indistinct streaks of a dark pattern and 5. tail laterally compressed with a distinct dorsal keel for almost the entire length of the tail, and the indistinct cross-stripes compressed only in the proximal half, the remainder of the tail uniformly yellowish (Fig. 6; Böhme, 2015). Examination of the skulls of the two species *Varanus griseus* and *Varanus nesterovi* by CT-scan and extraction of skull bones (the characteristics of the skull bones in

Figure 5. Photograph of a juvenile Bengal monitor lizard (*Varanus bengalensis*) captured in Bahu Kalat (Gandu) Protected Area (Oraie et al., 2024).

FIGURE 6. *Varanus nesterovi* in its natural environment at Mortka, Darbandikhan, Iraq (Böhme et al., 2023).

some lizards are a distinguishing feature between species) is true to some extent for the mentioned species; The similarity in the structure of the skull indicates a close relationship between the two species and their similar feeding method (Ghanbarinia.et al, 2019). The documented localities of *Varanus nesterovi* form a distribution range that appears to be wedged between the respective ranges of *V. g. griseus* and *V. g. caspius*. As far as known, it is confined to the western and southwestern margin of the Zagros Mountain range on both sides of the Iraqi-Iranian border, extending down to the area of Shiraz, Fars Province, Iran. It seems that *V. nesterovi* prefers more elevated habitats, having been recorded from 600 to 1100 m (Fig. 5; Böhme, 2015). *V. nesterovi* is an endemic inhabitant of the southwestern Zagros Mountain range (Fig. 7). Its distribution area in submontane to montane steppe habitats is wedged between those of its two much more widespread relatives: *V. griseus* in the west and *V. caspius* in the east (Böhme et al., 2023).

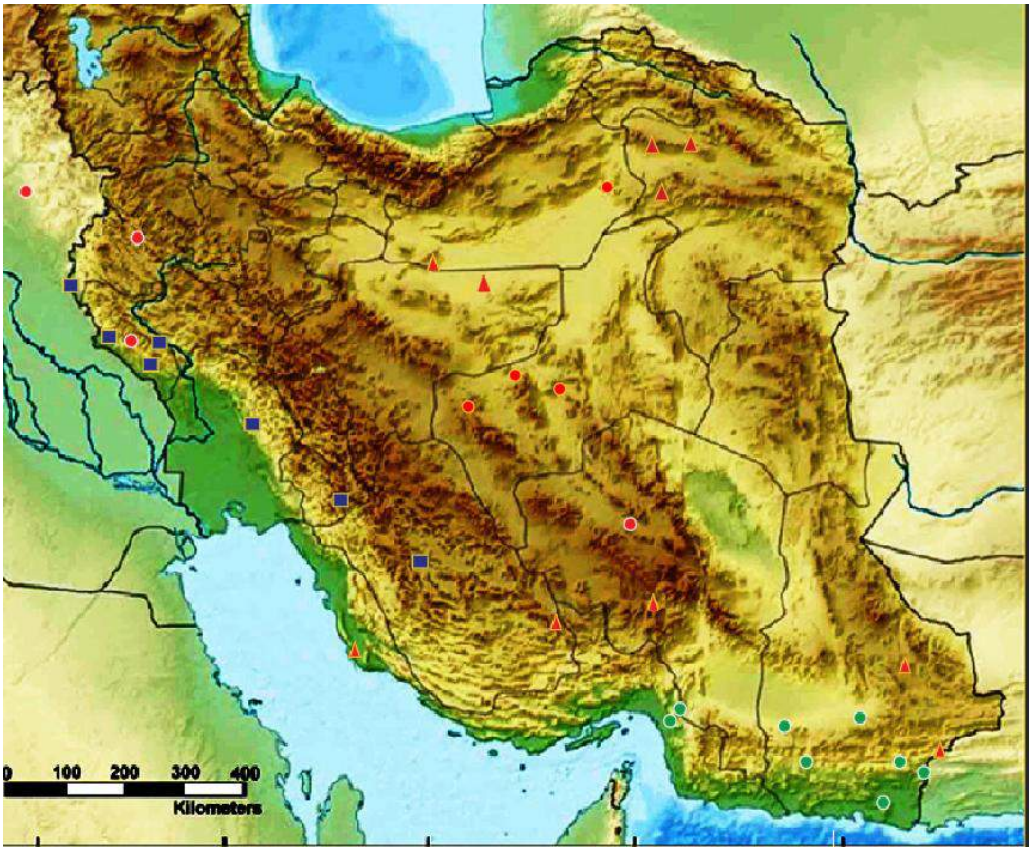

FIGURE 7. *Varanus* distribution map in Iranian plateau. *V. nesterovi* (blue square), *V. griseus* (red circle), *V. bengalensis* (green circle) and *V. caspius* (red triangle). The presence points shown in this map are approximate. (The map was taken from the articles, Böhme et al., 2023; Oraie et al., 2024; Böhme, 2015; Fathnia et al., 2009; Shafiei Bafti et al., 2021; Yousefi et al., 2023; Nasrabadi et al., 2016; Ebrahimi Pour et al., 2016).

CONCLUSION

The desert monitor lizard is the largest lizard in Iran, occurring across a wide area of the country. Consequently, maintaining suitable habitat for this species seems essential. Large areas in the northeast, south, and southwest of Iran are climatically favorable for the desert monitor lizard (Kafash, 2016). On the Iranian Plateau, four monitor species from two subgenera are present: *Psammosaurus* (including *Varanus griseus*, *Varanus caspius*, and *Varanus nesterovi*) and *Empagusia* (which includes *Varanus bengalensis*). *Varanus caspius* is an endangered species, and its distribution range has drastically changed, a trend expected to continue. Alarmingly, some protected areas have already become unsuitable habitats for this species (Shadloo et al., 2021). Furthermore, *V. bengalensis* has also been categorized as an endangered species (Oraie et al., 2024).

Given the similarity of the external and cranial features of *Varanus griseus* and *Varanus nesterovi*, as well as the proximity and, in some places, overlapping of their distribution areas, molecular studies are necessary to confirm their species separation. In recent years, we have witnessed the destruction of many animal habitats, including those of lizards, primarily due to human activities and climate fluctuations. Therefore, it seems necessary to examine the population dynamics, habitat status, and effects of climate fluctuations on other species. Further studies are also needed regarding their physiology, interspecific phylogeny, and other relevant aspects.

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RESEARCH ARTICLE Open access

Comparative insight into soil mite biodiversity (Laelapidae: Mesostigmata) across varied land use patterns in green spaces and their margins

Maryam Karbasian[1], Alireza Jalali Zand[1*], Hadi Ostovan[2], & Ebrahim Soleiman Nejadian[1]

[1] *Department of Plant Protection, Faculty of Agriculture, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran*
[2] *Department of Plant Protection, Faculty of Agriculture, Shiraz Branch, Islamic Azad University, Fars, Iran*

Abstract
Soil mites in urban areas represent a key component of the microfauna, contributing significantly to urban biodiversity by expanding the range of species within the local fauna. During the period of 2018-2019, a comprehensive study was conducted in Isfahan to assess the abundance and diversity of soil mites in parks and farms. A total of 15 mite species from the Laelapidae family, belonging to nine genera, were collected and identified. Remarkably, seven of these species, namely *Hypoaspisella patagoniensis, Pogonolaelaps canestrinii, Hypoaspis quadridentatus, Gymnolaelaps obscuroides, Gaeolaelaps neoaculeifer, Cosmolaelaps claviger*, and *Hypoaspisella asperatus*, were newly identified in the fauna of Isfahan. To analyze the diversity of species in different regions and habitats, biodiversity indices were employed. The study covered five regions: north, south, west, east, and center, comprising two types of habitats, namely green spaces and agricultural fields. The results revealed significant variations in biodiversity indices based on vegetation type and sampling season. In green spaces, the Shannon Wiener index reached its highest value of 2.336, while the Margalef species richness index peaked at 2.741. In contrast, these indices were relatively lower in agricultural areas, with values of 1.542 and 1.490 for the Shannon Wiener and Margalef indices, respectively. Seasonal variation also played a crucial role in species diversity. The spring season demonstrated the highest biodiversity, with a Shannon Wiener index value of 3.919 and a Margalef index value of 2.796. On the other hand, the winter season exhibited the lowest biodiversity, with a Shannon Wiener index of 1.683 and a Margalef index of 1.729. One particular species, *Euanderolaelaps karawaiewi*, was observed in both habitats and all five investigated regions, underscoring its significance in biodiversity assessments. In conclusion, this study sheds light on the diverse population of soil mites in Isfahan's parks and farms, and it highlights the influence of vegetation type and sampling season on mite diversity, providing valuable insights for future biodiversity conservation efforts.

Key words: Fauna, Richness index, Isfahan parks, Field, Diversity.

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INTRODUCTION

Biodiversity refers to the community of plant and animal populations in a particular area (Heidari Latibari et al., 2022). It encompasses various aspects such as diversity, population structure, and abundance patterns. The purpose of measuring biodiversity is to establish a single quantity for comparing different communities and ecosystems. Higher biodiversity indicates a more complex and sustainable ecosystem

*Corresponding Author: ✉ arjalalizand@gmail.com

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(Jenkins and Parker, 1998). Recent studies emphasize that biodiversity is decreasing in urban areas (Knapp et al., 2021).

Three terms are commonly used to measure biodiversity: alpha diversity (intra-habitat diversity), beta diversity (inter-habitat diversity), and gamma diversity (regional diversity). Gamma diversity can be divided into two types: one based on the number of species present in a geographical area, which increases with the number of species, and the other expressing the similarity or dissimilarity of species composition in different regions (Maguran, 1988, Qian et al., 2020). Understanding biodiversity and species diversity in each region is crucial for comprehending natural and engineered ecosystems, as well as ensuring the sustainability and health of the environment (Speight et al., 2008, Heidari Latibari et al., 2023). Soil, being one of the most vital and diverse habitats on Earth, harbors an array of living organisms that play essential roles in the environmental system (Timmis and Ramos, 2021). These living organisms, including mites, can serve as indicators to evaluate soil quality and environmental protection strategies (Dostar sharaf et al., 2015; Schloter et al., 2003).

Agricultural ecosystems and natural habitats exhibit significant differences in terms of biodiversity and the relative abundance of predatory mites (Wu et al., 2005). Among arthropods, mites stand out as important representatives of soil fauna due to their species diversity, ecological niche, and behavior (Zhang et al., 2023), making them valuable indicators of soil quality and environmental conditions (Bedano et al., 2005; Speight et al., 2008).

Mesostigmata mites, with approximately 12,000 identified species, are among the most diverse orders of mites and inhabit various environments, including soil, leaf soil, rotten plants, manure, animal nests, and plant surfaces (Walter and Proctor, 1999; Lindquist et al., 2009). The Laelapidae family of mites is particularly diverse in appearance and ecological characteristics, consisting of predatory and parasitic species, with 1316 species reported so far (Beaulieu et al., 2011). These mites play a crucial role in the soil food chain by feeding on nematodes, invertebrates, and arthropods, and their global distribution, high abundance, and predatory behavior make them excellent indicators for studying environmental conditions (Zhang, 2003). Biodiversity and the abundance of predatory mites vary significantly between agricultural ecosystems and natural habitats (Zhang et al., 2003). Protecting biodiversity is essential for maintaining ecosystem functioning in the long term (Dostar sharaf et al., 2015). Higher biodiversity indicates a healthier and more stable environment with better self-regulating conditions, emphasizing the importance of biodiversity for the health and sustainability of any region (Hajizadeh et al., 2009). Various factors, such as soil type, moisture, pH, and geographical location, influence the density of mites in the soil (Manu et al., 2022). Management strategies, forest vegetation, and human activities can also affect the quantitative and qualitative aspects of mite populations, including species diversity and numbers (Sabbatini et al., 2011).

Given recent agricultural practices and the use of pesticides, this study aims to compare the biodiversity of soil mites in agricultural areas and green spaces, as determining mite diversity can indicate soil quality and evaluate ecosystem management practices (Manu, 2013).

MATERIAL AND METHODS

To investigate the species diversity of soil mites belonging to the Laelapidae family in two distinct habitats, namely green spaces and agricultural lands, a comprehensive study was conducted in Isfahan. The research encompassed five regions (North (32°40'53" N, 51°38'22" E), South (32°35'42" N, 51°39'11" E), East (32°38'32" N, 51°42'50" E), West (32°38'17" N, 51°38'16" E), and Center (32°38'19" N, 51°38'50" E)), with each region containing two selected areas - one green space and one agricultural land, both measuring 100 square meters. Seasonal sampling was conducted at random intervals in these selected areas.

The sampling process involved placing collected samples from each area in a Burles funnel for 48 to 72 hours. The mites were encouraged to escape by exposing them to light, heat, and reduced humidity. Subsequently, the mites were collected in a container containing AG solution (a mixture of 70% white alcohol and 1-3% glycerin). Special brushes and needles were used to separate the mites from the AG

solution, and they were then transferred to containers containing a lactic acid clarifying agent for further processing. To prepare microscopic slides, Hoyer's fixing solution was utilized, ensuring the space under the lamellae was adequately covered with water to prevent the formation of air bubbles. The slides were placed in an oven at 45 degrees Celsius for one to ten days to achieve a permanent mixture of dry Heuer and transparent samples. Identification of the mite samples was carried out using valid taxonomic keys and the entomology book authored by Krantz and Walter (2009).

The study focused on several aspects, including determining the abundance of ticks by species, investigating the distribution of different species across different seasons, and exploring the relationship between soil and environmental conditions and the relative number of mite individuals. To quantify the diversity in each area and all sampled areas, various indices and biodiversity formulas were employed, such as the Shannon Winner index, Simpson index, Margalef index, and pit index. In order to calculate the species diversity indices, the number of species and the number of individuals were recorded based on the sampling time. The data analysis and graphs plotting was conducted using SPSS and SDR software.

RESULTS

Surveys conducted between 2018 and 2019 in Isfahan, covering five regions (North, South, East, West, and Center) and two habitats (green spaces and agricultural lands), revealed a diverse community of mites (Tables 1-6, 9). A total of 15 mite species from nine genera within the Laelapidae family were identified. Notably, four species—*Hypoaspis quadridentatus*, *Hypoaspisella patagoniensis*, *Hypoaspisella asperatus*, and *Gaeolaelaps neoaculeifer*—were previously unrecorded in Iran. Seven species, including *Pogonolaelaps canestrinii* and *Gymnolaelaps obscuroides*, were new to the region of Isfahan. Among the species, *Euandrolaelaps karawaiewi* had the highest frequency in both habitats, making up 19.39% of the population in green spaces and 44.64% in agricultural lands. Conversely, *Gymnolaelaps obscuroides* had the lowest frequency in agricultural lands at 1.78%, while three species tied for the lowest in green spaces at 1.21% (Figures 1 and 2). These results highlight the richness of soil mite diversity in Isfahan and the importance of green spaces and agricultural lands as habitats (Tables 7, 8,10). The discovery of previously unknown species adds to the scientific understanding of mites in Iran.

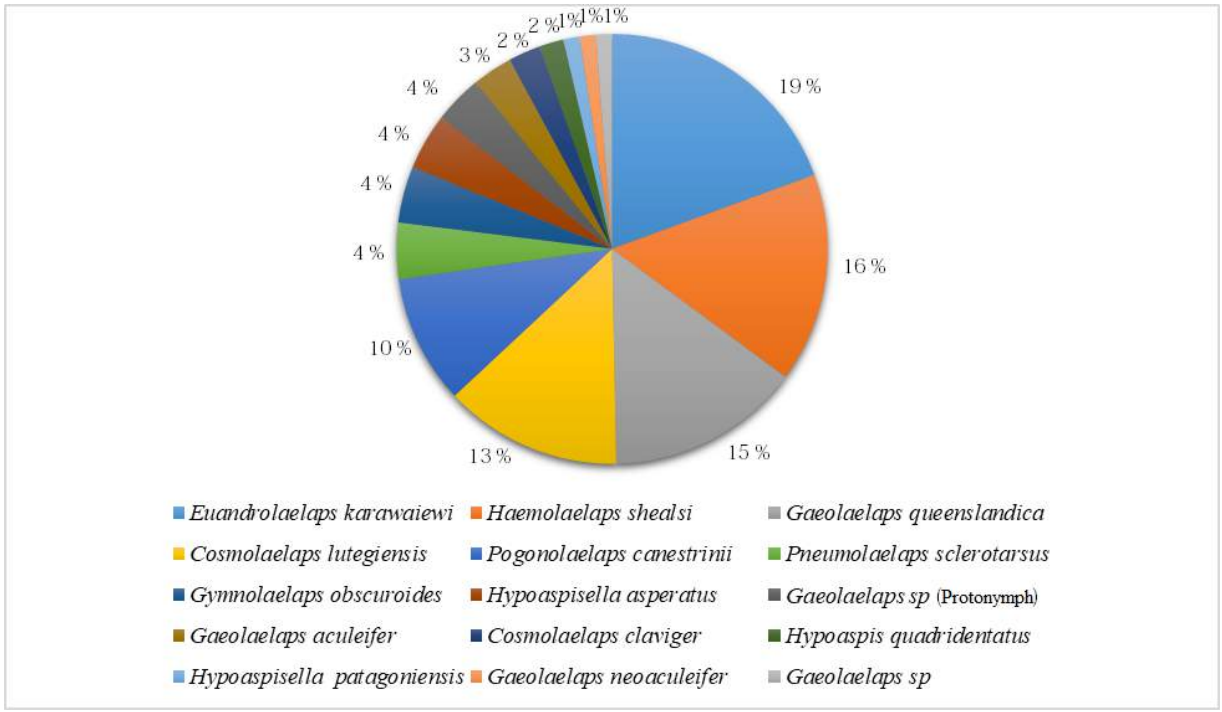

FIGURE 1. Relative frequency of various mites species found in Isfahan parks.

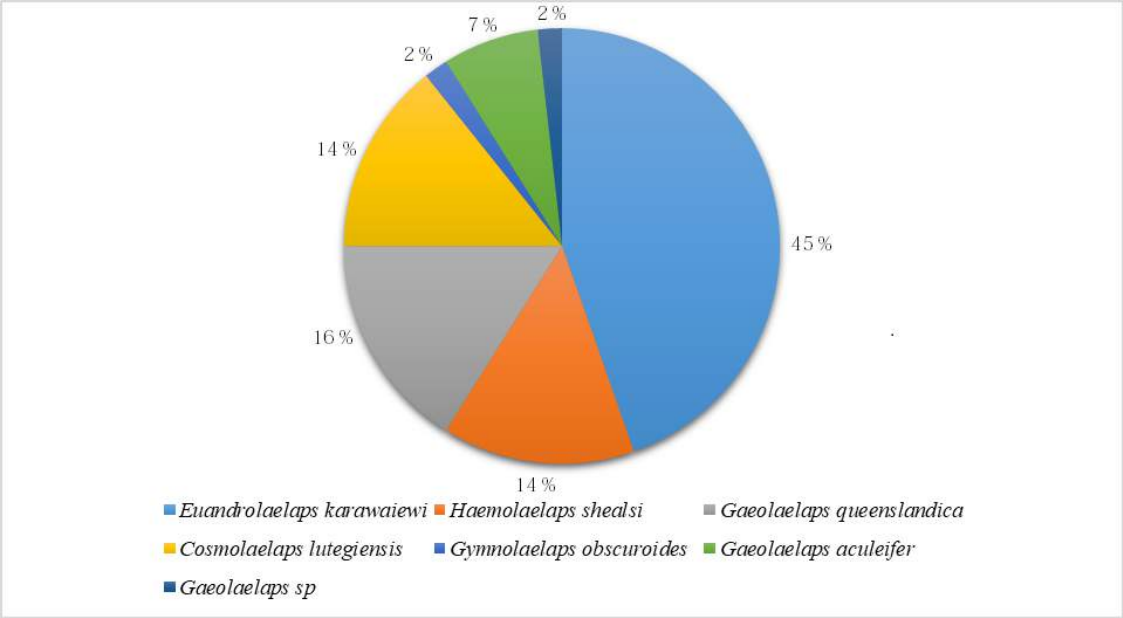

FIGURE 2. Proportional abundance of different mite species collected from Isfahan Agriculture lands.

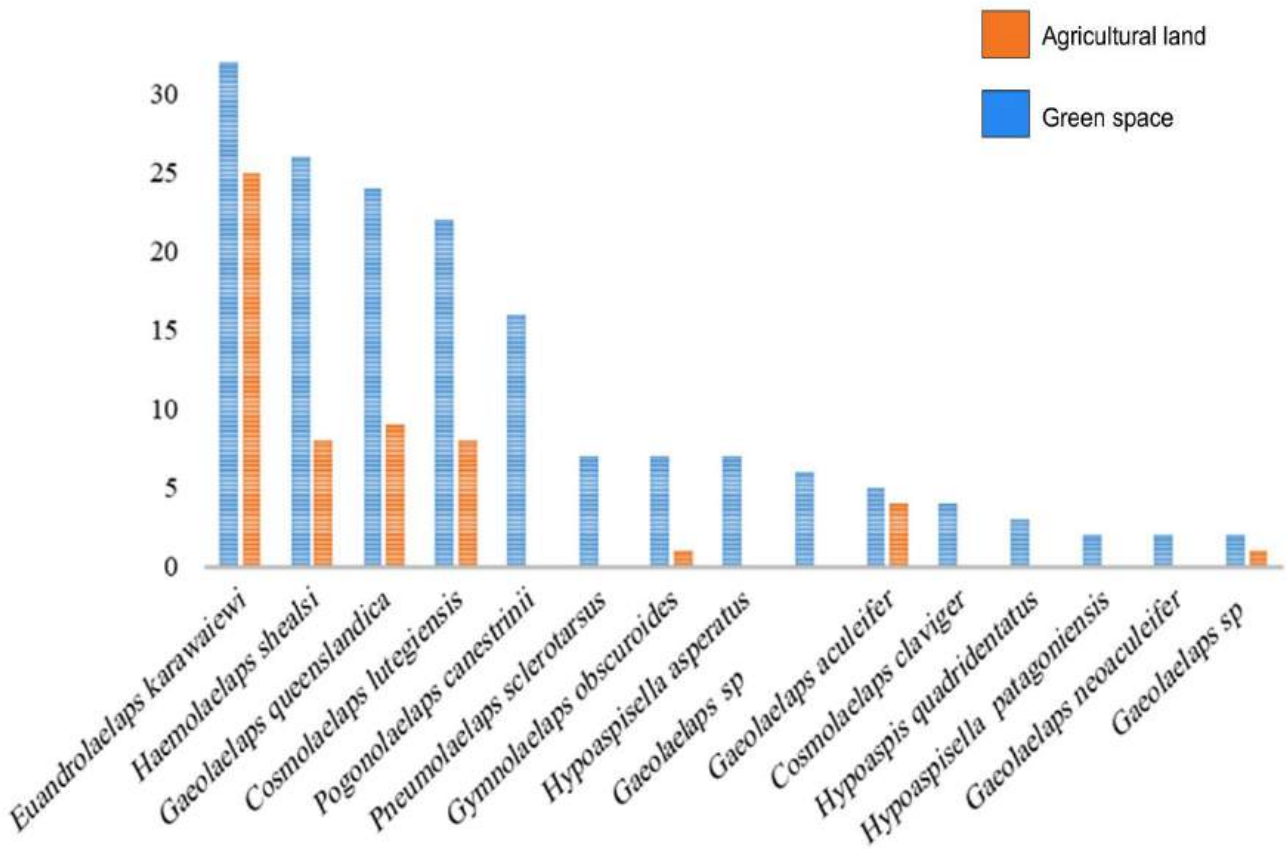

FIGURE 3. The relative abundance of different species of mites of the Laelapidae family collected from green and agricultural lands in Isfahan.

DISCUSSION

In ecosystems, stability and diversity are closely linked. Stability is often measured using the Shannon-Wiener index, with higher values indicating greater stability. The index typically ranges between 1.5 and 3.5. In this study, the Shannon-Wiener index was higher in green spaces (2.336) than in agricultural lands (1.542), a statistically significant difference. The greater intensity of agricultural activities, like pesticide use, likely contributed to lower biodiversity in agricultural lands. The seasonal analysis showed the highest diversity in spring, with a Shannon-Wiener index of 3.919, while winter had the lowest at 1.683, another statistically significant difference. Seasonal variations in biodiversity were likely influenced by changes in temperature and moisture, as previously noted by Salman (2000). The Simpson index, which focuses on dominant species, showed a higher value in green spaces (0.885) than in agricultural lands (0.741), indicating greater diversity in green spaces (Figure 3). Spring had the highest dominance index at 0.882. The Simpson index helps evaluate the likelihood that two randomly selected samples belong to different species.

The Margalef index, used to measure species richness, showed significant differences between green spaces and agricultural lands. Species richness and population size were lowest in winter. The Pit index, which measures species uniformity, was highest in green spaces during summer and lowest in agricultural lands during winter.

Overall, higher biodiversity in green spaces can be linked to similar climatic conditions, temperature, and humidity across habitats. The use of pesticides and agricultural activities like plowing may decrease mite populations in agricultural lands, reducing biodiversity. These findings align with Amani et al. (2014), who reported higher biodiversity in gardens due to fewer agricultural operations. Jenkins et al. (1998) also found that agricultural activities like plowing can compact soil and destroy food sources, reducing biodiversity. The species *Euandrolaelaps karawaiewi* was present in all areas, indicating its importance in biodiversity assessments. Area 4, which had dense vegetation and was farther from urban pollution, showed the highest number of mites, suggesting that vegetation cover plays a key role in biodiversity. Both green spaces and lands in Area 4 and Area 2, which had more trees and shrubs, had higher biodiversity, consistent with findings from Maleki et al. (2015).

Overall, the reduction in biodiversity in areas with intense agricultural activities highlights the importance of proper ecosystem management. Stable ecosystems with more vegetation cover show greater biodiversity, making them crucial indicators of ecosystem stability.

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RESEARCH ARTICLE Open access

Ecological Observations and New Distribution Records of *Lytorhynchus paradoxus* (Günther, 1875): Expanding Its Range Beyond the Desert Regions of Punjab, Pakistan

Mudassar Basri [1*], Muhammad Rehan [2]

[1] *Independent Researcher of Serpents, Khanewal, Pakistan.*
[2] *Institute of Mountain Hazards and Environment, University of Chinese Academy of Sciences, China.*

Abstract
The discovery of new localities for poorly understood species is important for advancing knowledge of their distribution and informing conservation efforts. This study presents the first detailed analysis of the Sindh Awl-headed snake, *Lytorhynchus paradoxus* (Günther, 1875) based on a field survey conducted in July and August 2024 in the Cholistan Desert, Yazman Mandi, Bahawalpur (29.10833°N, 71.74167°E), central-southern Pakistan. Six specimens were documented, providing insights into the species' distribution range, diel activity pattern and reproductive strategy. Previous records from Pakistan often lacked specific locality data, and this research addresses that gap by providing detailed morphological characteristics, sex identification, and exact geographic coordinates. Additionally, a recent sighting and subsequent killing of a specimen by a resident in Chak 50 WB, Vehari district, Punjab (30.108611°N, 72.159167°E), extends the known range of *L. paradoxus* by approximately 150 km, contributing a new locality to its distribution. These findings enhance the understanding of the species' ecology in arid environments and emphasize the need for further studies to assess its conservation status and ecological role within its habitat.

Keywords: *Lytorhynchus paradoxus*, Pakistan, Psammophilous, Cholistan, Snake.

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INTRODUCTION

Lytorhynchus paradoxus (Günther, 1875), commonly known as the Sindh Awl-headed snake, is a non-venomous colubrid snake (Anderson, 1898) native to the arid regions of the Indian subcontinent. Many desert-dwelling reptiles, including *L. paradoxus*, have not been extensively studied, leaving their ecological roles insufficiently understood (Baig et al., 2008). Historically, *L. paradoxus* was considered endemic to the Thar Desert of Pakistan, with early records largely confined to the Cholistan Desert and adjacent areas in Punjab, as well as parts of Sindh and Balochistan (Smith, 1943; Minton, 1966; Leviton & Anderson, 1970; Baig et al., 2008; Ali et al., 2012). Notable localities in Pakistan include the Cholistan Desert, Bahawalpur Division, Muzaffargarh, Multan, Hyderabad, Jacobabad, Sanghar, Thar Parkar, and Zhob Districts.

However, more recent surveys and reports have expanded the species known distribution beyond Pakistan. It has been recorded in Rajasthan, India, with sightings in Ramgarh and Sam in Jaisalmer District, and Chohtan in Barmer District (Bhide et al., 2004; Agarwal et al., 2009; Agarwal & Srikanthan, 2013; Yati et al., 2016). Early assumptions of its endemism in the Thar Desert have been questioned by

*Corresponding Author: ✉ : wildtraitpk@gmail.com

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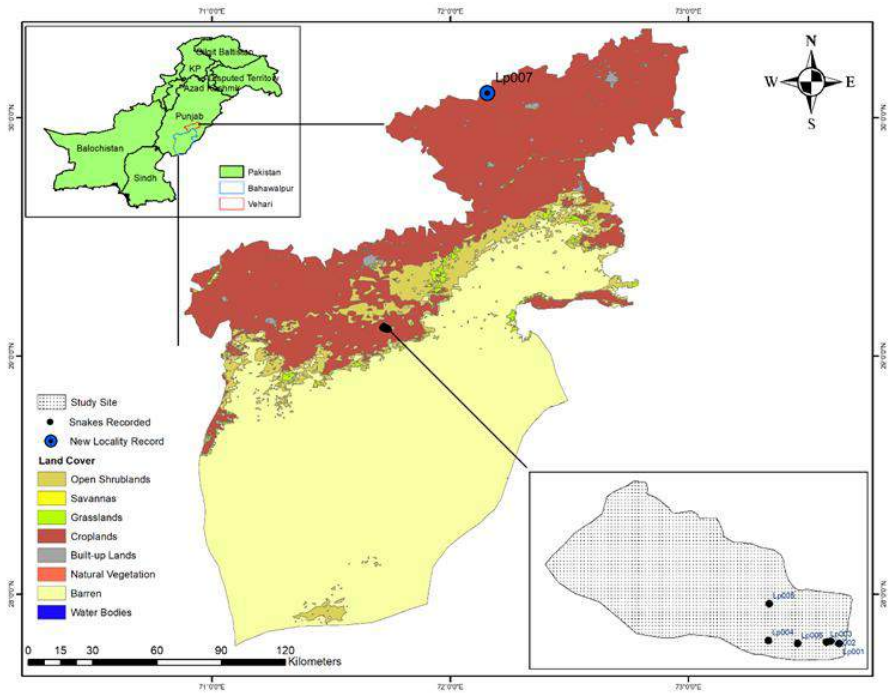

FIGURE 1. Map of the study area, showing the district of Bahawalpur and the newly recorded locality of *Lytorhynchus paradoxus* in district Vehari. The map also illustrates the land cover distribution across both districts.

these expanding records, suggesting that *L. paradoxus* may be more widespread and adaptable within desert habitats than previously thought. Recent field surveys, including this study, along with new sightings by local residents, further support the idea that this species is not as geographically restricted as previously believed.

Despite these growing distribution records, significant gaps remain in our understanding of *L. paradoxus*. Ecological data on its habitat preferences, activity patterns, and reproductive biology are limited. Desert snakes like *L. paradoxus* play important roles in regulating populations of small vertebrates and invertebrates, and their behavior can provide insights into the adaptability of species in harsh, arid environments (Sharma & Upadhyay, 2011). Furthermore, understanding the distribution and ecology of such species is critical for their conservation, as desert ecosystems are increasingly threatened by habitat degradation, climate change, and human encroachment (Babar et al., 2020).

This study addresses the existing knowledge gaps by providing a comprehensive overview of *L. paradoxus* distribution, including new locality records from the Cholistan Desert. We also presented new insights into the species physical characteristics, behavior, and ecological preferences. This study enhances the understanding of *L. paradoxus*, thereby informing conservation efforts and biodiversity management strategies. Additionally, this research contributes valuable data into the ecological roles of desert reptiles, a field that remains largely understudied in herpetology (Agarwal & Srikanthan, 2013; Yati et al., 2016).

MATERIAL AND METHODS

In July and August 2024, over two-months period, all specimens were collected using the hand-picking method, which is highly effective for collecting small reptiles, mainly when covering large areas with limited time in the fields (Baig et al., 2008). The survey was carried out by three individuals at the study sites, using hand lamps and torches to minimize the risk of encountering venomous snakes (Mukherjee, 2023). We also utilized snake hooks to inspect shrubs and bushes for hidden specimens. We used a 20x magnifying glass for scale counting and a digital Canon 200D SLR camera to photograph the specimens for detailed examination.

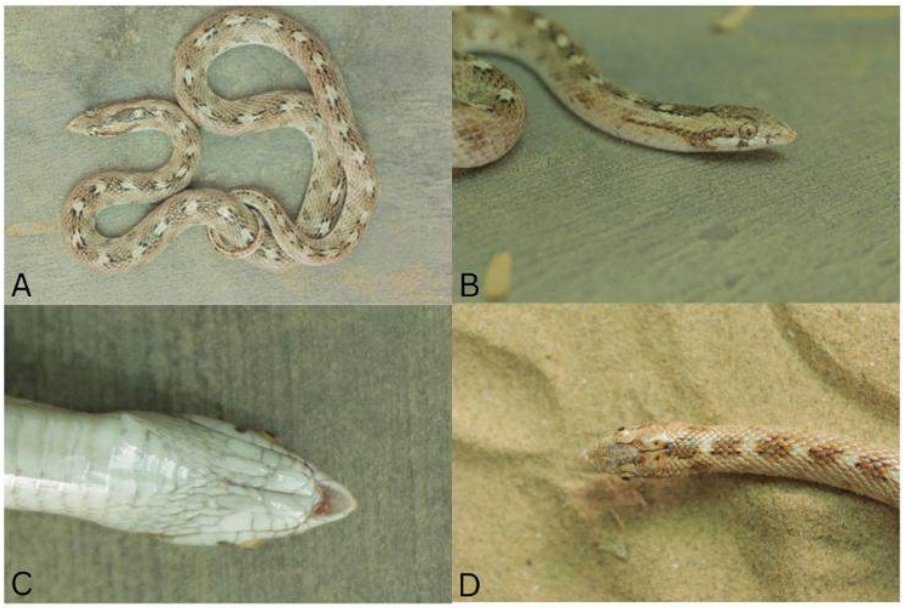

FIGURE 2. (A) Dorsal view of *Lytorhynchus paradoxus*, showing entire body morphological characteristics. (B) Lateral view (specimens Lp002, Lp004). (C) Ventral view of the head, highlighting the arrangement of infralabials and mental scales (specimen Lp005). (D) Dorsal view of the head, showing the prefrontal and frontal scales (specimen Lp006). Photographs by Mudassar Basri.

Gender identification was performed using popping and probing techniques (Creer et al., 2012; Harding & Callaghan, 2015). The probing involved gently inserting a sanitized and lubricated probe into the cloaca, directed towards the tail tip, to check for hemipenes in males (Lambert et al., 2009; Halliday & Adler, 2012). The popping or manual eversion technique involved applying firm but gentle pressure to the ventral side of the tail, approximately three-quarters of the way from the cloaca to the tip, and then sliding the thumb towards the cloaca (Buchan et al., 2005; Marshall et al., 2018). This method can cause the hemipenes to evert in males, appearing as two reddish structures, whereas in females, no such structures emerge (Aldridge & Brown, 1995; Hayes et al., 2009). While the popping method is generally considered less safe due to the potential for injury, it is effective when performed by professionals who carefully handle the technique.

Species identification was based on established literature (Smith, 1943; Minton, 1966; Leviton and Anderson, 1970; Bhide et al., 2004). Measurements were taken with a measuring tape in centimeters, and dorsal scale counts were recorded at mid-body (Ishan Agarwal and Achyuthan N. Srikanthan, 2013). Geographic coordinates for each collection site were recorded using GPS, information regarding weather conditions, habitat profile and activity and behavior of species were recorded (Moradi et al., 2013). The collected specimens were fed a diet of live juvenile mice and provided water ad-lib to maintain their health (Cooper, 2024). The collected snakes were released back into their natural habitat within a few days.

RESULTS

We collected six specimens (two females and four males) of *L. paradoxus* between 9:00 PM and 4:00 AM, demonstrating their nocturnal activity. The survey was conducted in an approximate 2 km by 6 km patch of Lesser Cholistan, situated west of Yazman Mandi, south of Chak 56 DB, north of Chak 101 DB and Chak 103 DB, and east of Chak 59 DB (Fig. 1). A local person from Chak 50 WB Vehari shared a photograph of a killed snake for identification. We identified it based on visible characteristics and confirmed it to be *L. paradoxus*. Detailed measurements, scale counts, coordinates, and timestamps for each specimen are provided in Table 1.Morphologically, all six specimens exhibited consistent features as described by Smith (1943), Minton (1966), and Leviton and Anderson (1970).

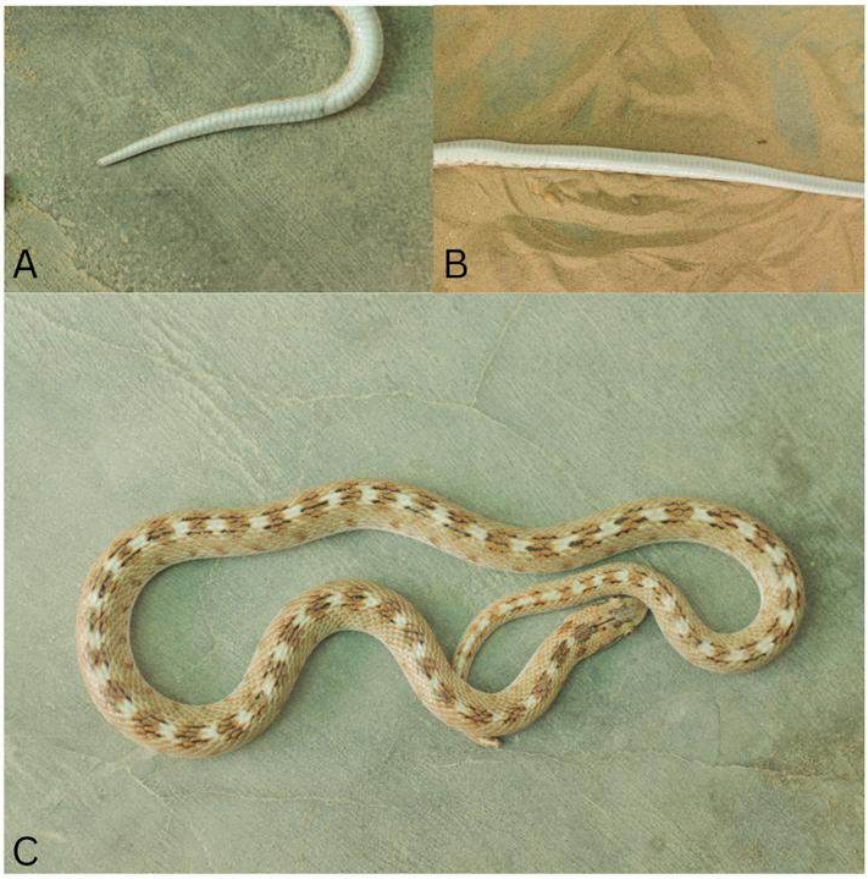

FIGURE 3. (A) Ventral view of *Lytorhynchus paradoxus*, showing subcaudal scale variation with 37 subcaudal scales (specimen Lp001). (B) Ventral aspect of *L. paradoxus*, exhibiting a patternless white coloration (specimen Lp003). (C) Complete dorsal view of *L. paradoxus* (specimen Lp001). Photographs by Mudassar Basri.

The rostral scale was pointed and visible from above. Each snake had eight supralabials, with the 5th in contact with the eyes. Loreal: 1, Preoculars: 2, Presubocular: 1, Postoculars: 2, and Anterior temporals: 2. dorsal scales were smooth, arranged in 19, mid-body rows, and the ventral scales ranged from 168 to 185, angulated laterally, with divided anal scale. The subcaudal scales were paired; older literature cites a range of 40 to 53. Notably, we recorded one female specimen with only 37 subcaudals. These snakes typically measured up to 40 cm in length. Their dorsal coloration was glossy greyish-brown with 40 to 51 white rectangular vertebral spots or alternating white and dark brown spots throughout the body, with dark brown or chocolate brown interspaces. The eyes had vertically elliptical pupils, the head was slightly broader than the neck, and it featured a depressed and pointed snout. The ventral side was patternless white (Figs. 2 and 3).

Habitat

The habitat of Lesser Cholistan, where we found *L. paradoxus*, is characterized by expensive sandy areas with sparse vegetation. This environment features low sand dunes and flat sandy patches, with flora including *Calotropis gigantean*, *Aerva javanica*, and *Citrullus colocynthis* (Fig, 4). These plants provide minimal cover. However, they are crucial for the ecosystem, offering shelter and foraging grounds for various species, including the observed reptiles. The sparse vegetation and sandy terrain are typical of arid desert environments, providing an ideal habitat for *L. paradoxus* and other desert-adapted wildlife.

TABLE 1. Morphometric, Meristic and Spatiotemporal Data of *Lytorhynchus paradoxus*. Abbreviations: **SVL** – Snout-Vent length; **TaL** – Tail Length; **TL** – Total Length; **V** – Ventral Scales; **A** – Anal Scale; **Sc** – Subcaudal Scales; **Dors** – Dorsal Scales; **SL** – Supralabials; **IL** – Infralabials; **L** – Loreal; **AT** – Anterior Temporals; **PrO** – Preoculars; **PtO** – Postoculars; **Alt** – Altitude; **Long** – Longitude; **Lat** – Latitude.

Characters	Lp001	Lp002	Lp003	Lp004	Lp005	Lp006	Lp007*
SVL (cm)	25	32.5	28.7	31.8	17.5	29	-
TaL (cm)	4	5.6	5.6	5	2.50	5	-
TL (cm)	29	38.1	34.3	36.8	20	34	-
V	181	176	171	183	177	177	-
A	2	2	2	2	2	2	-
Sc	37	43	46	44	42	45	-
Dors	19	19	19	19	19	19	-
SL	8(5)	8(5)	8(5)	8(5)	8(5)	8(5)	-
IL	9	9	9	9	9	9	-
L	1	1	1	1	1	1	-
AT	2	2	2	2	2	2	-
PrO	2	2	2	2	2	2	-
PtO	2	2	2	2	2	2	-
Sex	♀	♂	♂	♀	♂	♂	-
Alt (m)	74	81	82	82	82	80	132.83
Time	21:34:22	22:39:19	01:03:38	1:56:55	02:37:32	03:42:58	11:02:18
Date	27.07.2024	27.07.2024	28.07.2024	28.08.2024	28.08.2024	28.07.2024	25.06.2024
Long (Decimal)	71.74159	71.74073	71.74035	71.73465	71.73473	71.73750	72.15583
Lat (Decimal)	29.11174	29.11196	29.11188	29.11204	29.11563	29.11175	30.10287

Note: Lp007* was sighted and killed by local. Coordinates were obtained after visiting the location.

Behavior

Behaviorally, upon approach, the snakes initially attempted rapid escape, followed by diving through the sand. When further provoked, they coiled their bodies, hid their heads, and hissed, with some exhibiting caudal luring behavior. After the perceived threat had passed, the snakes would quickly escape. Tail curling was also noted, and notable, the snakes did not attempt to bite even once. According to our observations, they mainly feed on small beetles and juveniles of *Gerbillus cf. gleadowi* (Murray, 1886), but according to older literature, *Crossobamon orientalis* is also included in their diet. Field observations in 2020 and 2021 during April revealed that females typically laid a single egg.Other reptiles encountered during the survey included two *Spallerosophis arenarius* (Boulenger, 1890), Five to six *Crossobamon orientalis* (Blanford, 1876), numerous *Acanthodactylus cantoris* (Günther, 1864), and a single *Eremias cholistanica* (Baig & Masroor, 2006). No other snakes were recorded in the past two years, except for a *Platyceps ventromaculatus* (Gray, 1834) observed near the eastern edge of the study area on April 6, 2022, and a *Spalerosophis atriceps* (Fischer, 1885) spotted near a water disposal site on June 12, 2022. The latter location has become a source of pollution, further degrading this habitat.

FIGURE 4. Landscape view of study area, showing the habitat features of *Lytorhynchus paradoxus*. Photograph by Mudassar Basri.

FIGURE 5. Killed specimen of *Lytorhynchus paradoxus* (specimen Lp007) from Vehari. Photograph by Faisal Hashmi.

New Sighting

A new sighting of *L. paradoxus* was reported from Chak 50 WB, Vehari (30.108611°N, 72.159167°E), situated about 76 km away from the edge of the Cholistan Desert (Fig. 5). The specimen was found in a semi-arid environment characterized by sandy soil with sparse vegetation. The area shows patches of grass and scattered shrubs, indicative of a desert margin habitat. This type of habitat supports species adapted to arid conditions, with vegetation providing minimal cover and food resources.

DISCUSSION

Our study, in conjunction with the new sighting from Chak 50 WB, Vehari, suggests that *L. paradoxus* is not as rare as previously believed within its known distribution range. The sighting in Vehari, located approximately 76 km from the Cholistan Desert, challenges earlier assumptions that the species is restricted solely to true desert habitats. This finding aligns with more recent studies that have noted the adaptability of *L. paradoxus* to semi-desert and arid environments, broadening the understanding of its ecological range. Previously, *L. paradoxus* was primarily documented in the Cholistan Desert (Baig et al., 2008) and parts of Rajasthan, India (Agarwal et al., 2009; Yati et al., 2016). However, our results suggest that the species can also inhabit environments that are not strictly desert, supporting the hypothesis that *L. paradoxus* may be more ecologically flexible than originally thought (Bhide et al., 2004; Ishan Agarwal & Srikanthan, 2013).

Our findings further reveal that *L. paradoxus* is exclusively nocturnal, a behavioral trait that corroborates earlier observations made by Minton (1966) and Leviton & Anderson (1970), who noted the species tendency to be active during the night. This behavior is characteristic of many desert-dwelling snakes, which often rely on nocturnal activity to avoid the extreme heat of the day (Sharma & Upadhyay, 2011). In line with previous reports (Smith, 1943; Baig et al., 2008), we observed that *L. paradoxus* retreats to shelters such as vegetation roots or burrows during the day, indicating its adaptation to the hot, dry conditions of its habitat. The species diurnal inactivity and reliance on cryptic refuges during daylight hours are consistent with the behaviors of other desert colubrids, which utilize subterranean or vegetative cover for thermoregulation and predation avoidance (Sewlal & Minton, 1999).

Regarding reproductive behavior, our study corroborates the findings of Baig et al. (2008) that *L. paradoxus* typically lays one or two eggs per clutch. This low reproductive output may be linked to the species habitat in arid environments, where reproductive success is often limited by environmental factors such as temperature and food availability (Fitzgerald & LeFebvre, 2015). In this context, the species feeding habits, primarily targeting beetles from the *Pimeliinae* subfamily, also align with previous reports that indicate its preference for small arthropods, which are abundant in desert ecosystems (Agarwal et al., 2009).

Human-induced habitat destruction, particularly due to the expansion of housing and agricultural activities, represents a growing threat to *L. paradoxus*. As noted by Babar et al. (2020), desert-adapted species are increasingly at risk due to the conversion of arid landscapes into cultivated fields and urban developments. Our findings also suggest that *L. paradoxus* may exhibit some level of adaptability to modified landscapes, as evidenced by its presence in agricultural fields near human settlements. Similar observations have been made for other desert species, such as the desert monitor (*Varanus griseus*), which has been found to persist in disturbed habitats (Akman et al., 2023). This adaptability could offer *L. paradoxus* a degree of resilience to anthropogenic changes in its environment, but it also raises concerns about the long-term viability of populations in these altered habitats.

By integrating previous records with our new findings, we provide a more comprehensive understanding of *L. paradoxus* distribution, habitat preferences, and ecological requirements. Our study reinforces the importance of conserving both true desert habitats and semi-arid environments, which are crucial for the survival of *L. paradoxus* and other similarly adapted species. Conservation efforts should focus not only on the protection of pristine desert habitats but also on mitigating the impacts of human activities in these regions. As climate change and human encroachment continue to alter desert ecosystems, it is vital to monitor these populations closely to ensure their persistence in a rapidly changing world (Sharma & Upadhyay, 2011; Babar et al., 2020).

CONCLUSION

This study provides valuable herpetological insights into least concern but lesser-known *L. paradoxus*, documenting its distribution, morphology, and nocturnal behaviors in the Cholistan Desert and a new locality record from Chak 50 WB, Vehari. The species demonstrates remarkable adaptations to arid and semi-arid habitats, with observations of unique defensive strategies and feeding behaviors that deepen our understanding of its ecology. Human interactions, including habitat encroachment and accidental killings, highlight this species' challenges. These findings emphasize the importance of targeted conservation efforts and continued herpetological research to safeguard both *L. paradoxus* and the fragile ecosystems it inhabits.

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