

Tarbiat Modares University Press  
Entomological Society of Iran**Research Article**  
Taxonomy<https://doi.org/10.61186/jibs.10.3.467>

ISSN: 2423-8112

<https://zoobank.org/urn:lsid:zoobank.org:878AE198-7370-48AE-8F85-58CA95E12825>

## Aphids associated with *Carthamus* in Iran with the description of the hitherto unknown male of *Uroleucon carthami* (Hille Ris Lambers, 1948) (Hemi.: Aphididae)

**Mohsen Mehrparvar**

Department of Biodiversity, Institute of Science and High Technology and Environmental Sciences, Graduate University of Advanced Technology, Kerman, Iran.

✉ [mehrparvar@kgut.ac.ir](mailto:mehrparvar@kgut.ac.ir)

<https://orcid.org/0000-0002-6051-5845>

**Mansour Mirtadzadini**

Department of Biology, Faculty of Science, Shahid Bahonar University of Kerman, Kerman, Iran.

✉ [mirtadzadini@yahoo.com](mailto:mirtadzadini@yahoo.com)

<https://orcid.org/0000-0003-1101-3344>

**ABSTRACT.** Aphids constitute a significant cohort of herbivorous insects, primarily nourishing themselves by extracting plant sap, sometimes posing a notable threat to plant health. Here, we present a comprehensive investigation into the aphid fauna associated with *Carthamus* in Iran, unveiling 18 species across 11 genera within the Aphididae. Furthermore, 31 associations between aphid species and host plants were recognized, of which two are new for Iran. Our study expands upon prior knowledge by documenting three new occurrences, shedding light on previously unrecorded aphid species in Isfahan and Razavi Khorasan provinces. In addition, we describe the previously unknown male of *Uroleucon carthami*, offering insights into its life cycle and reproductive strategies. An identification key to the apterous viviparous female aphids living on *Carthamus* in Iran is provided.

**Keywords:** fauna, taxonomy, safflower, distribution, sexual morph

**Received:**

09 February, 2024

**Accepted:**

31 March, 2024

**Available online:**

13 April, 2024

**Subject Editor:**

Ehsan Rakhshani

**Citation:** Mehrparvar, M. & Mirtadzadini, M. (2024) Aphids associated with *Carthamus* in Iran with the description of the hitherto unknown male of *Uroleucon carthami* (Hille Ris Lambers, 1948) (Hemi.: Aphididae). *Journal of Insect Biodiversity and Systematics*, 10 (in press).

## INTRODUCTION

The genus *Carthamus* L. (Asterales, Asteraceae), comprises 26 species among them, *C. tinctorius* is an important cultivated agricultural crop and the rest are wild and weedy in habit. Safflower holds rich variability for different traits of economic importance and contains high levels of flavonoids, tocopherols (Gupta, 2016), monounsaturated (oleic acid) and polyunsaturated (linoleic acid) fatty acid. They are native to Europe, North Africa, and parts of Asia (Tankahya-Hacioğlu et al., 2014). These plants, like other plants, have their pests, among which aphids are an important group that cause significant damage (Nivedita et al., 2019; Gorji et al., 2023). So far, 28 species of aphids have been identified on *Carthamus* in the world (Blackman & Eastop, 2024), of which 18 species have been reported in Iran (Mehrparvar, 2024a). In between, some species including *Amphorophora* sp. (Rezwani, 1987), *Macrosiphoniella* sp. (Sedighi et al., 2020), *Pleotrichophorus glandulosus* (Kaltenbach, 1846) (Rezwani, 2010) and *Uroleucon cichorii* (Koch, 1855) (Rezwani, 1987; Hodjat, 1993) are only reported in Iran which their association with *Carthamus* need further confirmations. Concerning *P. glandulosus*, Blackman & Eastop (2024) believe that records from other genera than *Artemisia* are probably of vagrants, or based on misidentifications.

**Corresponding author:** Mehrparvar, M., ✉ [mehrparvar@kgut.ac.ir](mailto:mehrparvar@kgut.ac.ir)

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Aphids are notorious agricultural pests that can damage crops by feeding on plant sap, transmitting plant viruses, and secreting honeydew which promotes the growth of mould (van Emden & Harrington 2007). The study of aphid fauna and their associated host plants in Iran is important for various reasons, as these insects play a significant role in ecosystems and have various interactions with other organisms, making them an integral part of ecosystems so they have both economic and ecological implications. Understanding the diversity, distribution, and biology of aphid species is crucial for developing effective pest management strategies to protect crops and enhance agricultural productivity.

The aphid genus *Uroleucon* Mordvilko, 1914 in particular, has been identified as a key taxon associated with *Carthamus*. Hille Ris Lambers (1948) described *Uroleucon carthami*, as an aphid species associated with wild safflower (*C. glaucus*), but its sexual morphs have been not described till now. In this study, we address the gap in our knowledge by providing a comprehensive investigation of the aphid species associated with *Carthamus* in Iran. Moreover, we present detailed descriptions of the previously unknown male of *Uroleucon carthami*, shedding light on the life cycle and reproductive strategies of this specific aphid, and provide an identification key to the apterous viviparous female aphids on *Carthamus* in Iran.

## MATERIAL AND METHODS

The results presented in this article consist of two groups of information: those obtained from relevant and credible sources that have been previously published and those derived from the sampling conducted by the first author and specimens available in the Aphid Collection of the Aphidology Research Group (ARG), Kerman, Iran. To collect aphids residing on their respective host plants, a meticulous examination of both foliage and roots was conducted to identify colonies. Upon locating aphid colonies, infested plant parts were delicately severed and carefully placed into plastic containers. In instances where direct observation of aphids on plants proved challenging, certain indicators such as the presence of aphid honeydew on plant surfaces, the attendance of ants, and the presence of predators were employed. In cases where no aphids were visibly present on plants, the method of beating onto a white tray positioned beneath the plant proved to be highly effective. Subsequently, the gathered aphids were carefully collected using a paintbrush, and specimens were preserved in 75% ethanol.

During the collection process, detailed sampling data, including the host plant's name, feeding location on the host plant, the colour of live aphid specimens, locality, date, biological information, geographical coordinates, elevation, and the presence of attending ants, were recorded. In the laboratory, the specimens underwent mounting on microscopic slides following the methodology outlined by Mehrparvar et al. (2021) and Mehrparvar (2024b). The identification process was carried out utilizing pertinent resources such as Blackman (2010), Blackman & Eastop (2006, 2024) and Heie (1992, 1994, 1995). These specimens have been catalogued and are now deposited in the Aphid Collection of the Aphidology Research Group at the Graduate University of Advanced Technology (KGUT) in Kerman, Iran. The measurements were conducted as outlined by Blackman and Eastop (2006). The present host plant names are referenced based on The WFO Plant List (2023).

Abbreviations used in the text are as follows: BL, body length; ANT, antennae length; ANTI, ANTI, ANTI, ANTI, ANTI, ANTI, antennal segments I, II, III, IV, V, VI and the base of antennal segment VI, respectively; PT, processus terminalis; HW, head width across eyes; URS, ultimate rostral segment; HTII, second segment of hind tarsus; SIPH, siphunculus; BDANTI, basal diameter of the third antennal segment; LHANTI, longest hair on third antennal segment; HF, hind femur length; HT, hind tibiae length; LHHF, longest hair on hind femur; ABDT, abdominal tergite; ARG, Aphidology Research Group.

## RESULTS

A total of 40 specimens collected from various *Carthamus* species were examined. This, combined with information from existing sources, expands the recorded tally to 18 aphid species within 11 genera, three tribes, and two subfamilies within the family Aphididae, identified on four host plant species of *Carthamus* in Iran. Notably, three new occurrences have been documented for the first time in Isfahan and Razavi Khorasan provinces. Furthermore, the study reveals a total of 31 associations between aphid species and host plants, with two of these associations being novel for Iran. The detailed compilation of host plants and the distribution of aphid species associated with *Carthamus* species in Iran is presented in Table 1, with the noteworthy reports indicated by an asterisk "\*." The ensuing section provides an overview of aphid species associated with *Carthamus* in Iran, encompassing specimens collected in the present study and those documented in prior publications

### *Taxonomic hierarchy*

**Class Insecta Linnaeus, 1758**

**Order Hemiptera Linnaeus, 1758**

**Family Aphididae Latreille, 1802**

**Subfamily Aphidinae Latreille, 1802**

**Tribe: Aphidini Latreille, 1802**

***Aphis fabae* Scopoli, 1763**

Apterae exhibit a subdued black colouration, occasionally with white wax markings. Their body length ranges from 1.5 to 3.1 mm. This species presents numerous subspecies, contributing to a complex taxonomic situation. Being polyphagous, it demonstrates a broad spectrum of secondary hosts (Blackman & Eastop, 2024). With an almost global distribution, this aphid species has been documented in temperate regions of the northern hemisphere, as well as in South America and Africa (Blackman & Eastop, 2024). While it exhibits a widespread distribution across all provinces in Iran, its presence on *Carthamus* has only been in Isfahan and Kermanshah (Samii, 1992; Ghahramani Nezhad et al., 2012).

**Material examined.** ARG00582: Iran, Isfahan province, Isfahan, on *Carthamus* sp., 10-XII-2002, leg. Mohsen Mehrparvar.

***Aphis solanella* Theobald, 1914**

Apterae display a subdued black colouration, occasionally featuring white wax markings, with a body length ranging from 1.2 to 2.6 mm. This species is found on a diverse array of herbaceous plants, sharing habitats with its close relative *Aphis fabae*. Notably, it distinctly colonizes *Solanum nigrum* and *Fallopia convolvulus* (Stroyan 1984; Blackman & Eastop, 2024). It is distributed in Europe, Asia, Africa, and South America (Blackman & Eastop, 2024). Although it is widely distributed across all provinces in Iran, its occurrence on *Carthamus* has been documented exclusively in Fars (Goodarzifar et al., 2010) and Sistan and Baluchestan (Bameri Din, 2020).

**Material examined.** ARG00213: Iran, Sistan and Baluchestan province, Bampur, alt. 518 m., on *Carthamus tinctorius*, 24-III-2019, leg. Zeinab Bameri.

***Protaphis anuraphoides* (Nevsky, 1928)**

Apterae display shades of green to dark green, adorned with a mealy wax coating, with a body length ranging from 1.5 to 2.1 mm. Notably, it bears a close resemblance to *P. carthami*. This species predominantly inhabits plants belonging to various Asteraceae genera within the tribe Cardueae, including *Carthamus*, *Carduus*, *Cirsium*, *Cousinia*, and *Onopordum*. They are commonly found in abundance on the upper sides of leaves, stems, and flowerheads. This aphid species is reported in Ukraine, southern Russia, and southwestern and Central Asia (Blackman & Eastop, 2024). This species has been reported in Alborz, Lorestan, and West Azerbaijan provinces in Iran (Mehrparvar, 2024a), but

its occurrence on *Carthamus* has been observed exclusively in Urmia, West Azerbaijan (Rezwani & Parvizi, 1990).

**Material.** Not examined.

### *Protaphis carthami* (Das, 1918)

Apterae exhibit a dark green or reddish-brown colour, covered in greyish-white wax, often featuring a pair of dark spots on the dorsal abdomen just anterior to the siphunculi. Body length ranges from 1.4 to 2.3 mm. Notably, it closely resembles *P. anuraphoides*. Apterae possess secondary rhinaria distributed on the third (0–6) and fourth (0–2) antennal segments; however, in the specimens examined in this study, the number for the third antennal segment is elevated to 0–8. Similarly, for alatae, the number is 5–7 on the third segment, but in the examined specimens in this study, it is increased to 7–11. *Protaphis carthami* is typically found on stems and flowers of *Carthamus tinctorius* and other *Carthamus* spp., often attended by ants. This species is documented in North Africa, Lebanon, Iran, Kazakhstan, Pakistan, and northwest India (Blackman & Eastop, 2024). This aphid species has been reported only from Alborz, Fars and Kerman provinces in Iran on *Carthamus* spp. (Mehrparvar, 2024a); and this is the first report from Razavi Khorasan province.

**Material examined.** ARG00278: Iran, Fars province, Eghlid, alt. 2198 m., on *Carthamus oxyacantha*, 07-V-2020, leg. Moein Rokni. ARG00283: Iran, Fars province, Ghader Abad, alt. 1908 m., on *Carthamus oxyacantha*, 19-VIII-2020, leg. Moein Rokni. ARG00029: Iran, Kerman province, Mahan, alt. 1929 m., on *Carthamus oxyacantha*, 17-VI-2015, leg. Mohsen Mehrparvar. ARG00115: Iran, Kerman province, Mahan, alt. 1929 m., on *Carthamus oxyacantha*, 25-V-2015, leg. Mohsen Mehrparvar. ARG00586: Iran, Razavi Khorasan province, Chehelmir road, alt. 878 m., on *Carthamus oxyacantha*, 3-VI-2015, leg. Mohsen Mehrparvar.

### *Protaphis pseudocardui* (Theobald, 1915)

Apterae display a distinctive dark green or brown hue covered with a layer of grey mealy wax, featuring short black siphunculi. Additionally, there is commonly a pair of dark spots on the dorsal abdomen, just anterior to the siphunculi, with a body length ranging from 1.5 to 2.0 mm. These aphids form often densely populated colonies on stems, upper sides of leaves, flowerheads, or root collars of various Asteraceae plants and are ant-attended. Their presence has been documented in Africa, the Mediterranean region, the Middle East, and Georgia. It is worth noting that some of these records might be attributed to other closely related species, such as those within the *terricola* group (Blackman & Eastop, 2024). In Iran, this species is only reported from Razavi Khorasan (Mortazavi et al., 2015) and Tehran (Rezwani et al., 1994) provinces.

**Material.** Not examined.

## Tribe Macrosiphini Wilson, 1910

### *Acyrtosiphon ilka ilka* Mordvilko, 1914

Syn.: *Acyrtosiphon bidentis* Eastop, 1953

Apterae are green, often with darker green dorsal cross-bands. Body length is 1.4–2.7 mm. This aphid lives on various plant species belonging to different families such as Papaveraceae, Asteraceae, Brassicaceae and Linaceae (Blackman & Eastop, 2024). It is distributed in southern Europe, the Middle East, Central Asia, Pakistan, south Siberia, China and Africa (Blackman & Eastop, 2024). In Iran, this species is reported from Alborz, Kerman, Khuzestan, Markazi, Mazandaran, Tehran, and West Azerbaijan provinces (Mehrparvar, 2024a).

**Material.** Not examined.

### *Brachycaudus (Prunaphis) cardui* (Linnaeus, 1758)

Apterae found on herbaceous plants exhibit a glossy black dorsal surface, while their ventral side

appears light green to yellowish or reddish (immatures display green or reddish colour). They measure between 1.9 and 2.3 mm in body length. *Brachycaudus cardui* thrives in dense colonies attended by ants, residing on the stems and leaves of numerous plant species, especially on Asteraceae and Boraginaceae. This species is distributed across Europe, Asia, North Africa, and North America (Blackman & Eastop, 2024). While it is prevalent across all provinces in Iran, the occurrence of this species on *Carthamus* has solely been documented by Sedighi et al. (2020) exclusively in North Khorasan province.

**Material examined.** ARG00580: Iran, North Khorasan province, Asadli, alt. 1910 m., on *Carthamus lanatus*, 6-I-2017, leg. Neda Sedighi. ARG00581: Iran, North Khorasan province, Asadli, alt. 1910 m., on *Carthamus lanatus*, 6-I-2017, leg. Neda Sedighi.

### *Brachycaudus helichrysi* (Kaltenbach, 1843)

Apterae display a remarkably variable range of pale colours, including pale green, pale yellow, whitish, or pinkish, with a body length ranging from 0.9 to 2.0 mm. In the Iranian population, there are some biometric differences compared to what is mentioned in the literature. In the Iranian population, the ratio of SIPH/Cauda and ANTIII/HTII is 1.7–2.14 and 2.4–2.77, respectively, whereas these ratios are 0.8–1.5 and 0.9–2.2 in Blackman & Eastop (2024). Heie (1992) mentioned the URS/HTII ratio as 1.2–1.3 for *B. helichrysi* in the key for species of *Brachycaudus*. However, in the examined specimens in this study, this ratio was found to be 1.38–1.41. They are commonly found on stems and in flowerheads of numerous plant species, particularly those belonging to Asteraceae and Boraginaceae, but also on many others. This species has a global distribution and is recognized as a significant agricultural pest (Blackman & Eastop, 2024). While widely distributed across all provinces in Iran, the presence of this species on *Carthamus* so far has been exclusively documented in Fars province by Goodarzifar et al. (2010), therefore this is the first report of this aphid species on *Carthamus* in Kerman province. In addition, there has not been any record of this aphid species on *C. tinctorius* in Iran so far; therefore, this association is new for Iran.

**Material examined.** ARG00583: Iran, Kerman province, Mahan, alt. 1929 m., on *Carthamus tinctorius*, 2-IX-2015, leg. Zahra Gorji.

### *Capitophorus elaeagni* (Del Guercio, 1894)

Apterae within spring populations exhibit a pale green colour, measuring 1.9–2.5 mm in length. They are commonly found on the undersides of leaves of *Elaeagnus* spp. The alatae, generated in the second and third generations, take flight towards some Asteraceae plants. Apterae residing on secondary hosts display a palette ranging from pale greenish white to yellowish green, characterized by dark tips on their siphunculi; they measure 1.4–2.5 mm. These individuals predominantly feed on the undersides of lower leaves. It has a widespread distribution, encompassing temperate and warm temperate regions across the globe (Blackman & Eastop, 2024). This aphid species is widely distributed across Alborz, Fars, Gilan, Golestan, Markazi, Mazandaran, Tehran and West Azerbaijan provinces in Iran (Mehrparvar, 2024a). However, the documentation of its presence on *Carthamus* has been exclusively reported in Fars province by Goodarzifar et al. (2010).

**Material.** Not examined.

### *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

Apterae display a range of colours, including whitish, pale yellowish-green to mid-green, rose-pink, or red, with a body length ranging from 1.2 to 2.1 mm. In terms of its biology, this species stands out as the most polyphagous aphid globally. It has a heteroecious holocyclic life cycle, migrating to secondary hosts across more than 40 different plant families, and plays a crucial role as a vector for numerous plant viruses (van Emden & Harrington, 2007). Regarding its distribution, this species is found worldwide (Blackman & Eastop, 2024). However, it is widely distributed in Iran, but its occurrence on *Carthamus* is reported only in Fars (Goodarzifar, 2010) and Kermanshah (Ghahramani Nezhad et al., 2012) provinces.

**Material.** Not examined.

### *Uroleucon (Uromelan) carthami* (Hille Ris Lambers, 1948)

The apterae exhibit a dark brown to blackish-brown colour in life, with a body length ranging from 2.1 to 3.3 mm. These aphids are found on *Carthamus* spp. In European literature, there is occasional confusion with the closely related *U. jaceae* and *U. aeneum*, typically associated with other Cynareae but occasionally found on *Carthamus* (Nieto Nafría et al., 1986; Blackman & Eastop, 2024). The sexual morphs and life cycle of this species so far remain unknown. This aphid species is reported from southern and central Europe, Algeria, Israel, Lebanon, Türkiye, and extends eastward to Pakistan and India (Kashmir) (Blackman & Eastop, 2024). *Uroleucon carthami* has been reported from several provinces in Iran including Alborz, Fars, Kerman, Markazi, North Khorasan, Razavi Khorasan, Sistan and Baluchestan, Tehran, West Azerbaijan; however, the report of this aphid on *Centaurea iberica* from Markazi province by Alikhani et al. (2010) needs further confirmation. This is most likely *U. jaceae*, a species very close to *U. carthami*.

In 1948, Hille Ris Lambers described *U. carthami* based on a few apterous and alatae viviparous females collected on *C. glaucus*. While the author acknowledged the strong similarity between *U. carthami* and *U. jaceae*, but did not provide clear distinguishing differences between these two species, unless stating that: *U. carthami* bears a strong resemblance to *U. jaceae*, yet there are distinct features that set them apart. Unlike *U. jaceae* and its subspecies, where the rhinaria on the third antennal segment are small, they are noticeably larger in *U. carthami* and cover a slightly larger portion of the segment in apterae. The siphunculi exhibit marked differences, being much stouter, and the subapical constriction imparts a distinctive appearance (Hille Ris Lambers, 1948). Upon examining numerous specimens in this study, it became evident that differentiating between Iranian populations of *U. carthami* and *U. jaceae* collected on *Carthamus* spp. poses a significant challenge. These specimens exhibit overlapping biometric characteristics utilized in identification keys, such as the *Carthamus* key in Blackman and Eastop (2024) and also Eastop (1985). In the Blackman and Eastop (2024) identification key for aphids on *Carthamus*, the distinguishing features of the two species are: URS/ANTVib (1.05–1.4 for *U. carthami* and 0.95–1.15 for *U. jaceae*), number of rhinaria on ANTIII (15–34 for *U. carthami* and 23–45 for *U. jaceae*) and number of hairs on cauda (19–29 for *U. carthami* and 13–28 for *U. jaceae*) while for the Iranian populations they are (0.99)1.01–1.31 for *U. carthami* and 0.89–1.22 for *U. jaceae*, 15–39(49) for *U. carthami* and 21–55(61) for *U. jaceae*, and 18–32 for *U. carthami* and 18–30 for *U. jaceae*, respectively. These differences practically do not help to separate these two species reliably at least for Iranian populations. Sedighi et al. (2020) in their paper indicated the presence of an unknown *Uroleucon* species on *Carthamus lanatus* in Sisab, North Khorasan province. Further examinations of those specimens were conducted in this study, and eventually, they were identified as *U. carthami*.

**Description.** — **Alate male** (n=10, ARG00587) (Figs 1–2). Colour in life is dark red to blackish-brown. Color of mounted specimens: head and thorax brown; ANTI, ANTII and ANTIII dark brown except basal part of ANTIII; ANTIV–VI paler; URS dark brown; coxae brown; trochanter dusky with the same color as basal part of femora; femora dusky with dark brown distal halves; tibiae brown with dark brown apices; tarsi dark brown; SIPH dark brown; cauda brown (Fig. 1).

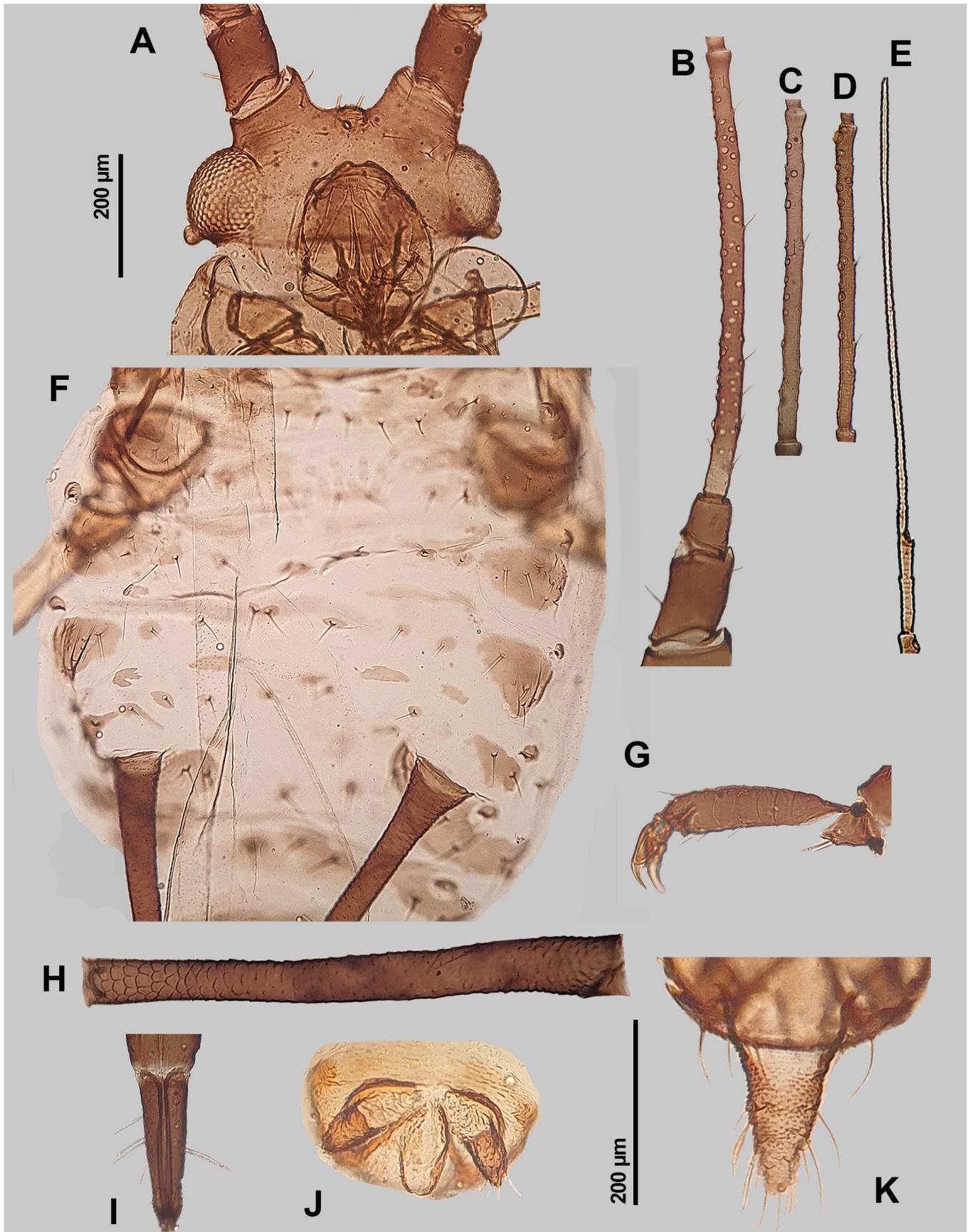
Body elongated spindle-shaped; head smooth; antennal tubercles moderately developed. BL (excluding cauda) 2.04–2.55 mm. Head with fine setae with pointed apices, 0.027–0.044 mm long. ANT 2.59–2.92 mm, 1.12–1.29 × BL. ANTI 0.12–0.13 mm. ANTII 0.08–0.09 mm. ANTIII 0.66–0.78 mm, with 36–53 mostly rounded, different-sized secondary rhinaria which distributed on almost whole length of ANTIII (Fig. 2B). ANTIV 0.45–0.54 mm, with 4–12 secondary rhinaria (Fig. 2C). ANTV 0.43–0.54 mm, with 8–14 secondary rhinaria (Fig. 2D). ANTVI 0.85–0.96 mm, ANTVib 0.15–0.18 mm, PT 0.70–0.79 mm, 1.40–1.57 × HW, 1.24–1.56 × SIPH and 4.31–4.61 × ANTVib. Other antennal ratios: ANTIII/ANTIV 1.35–1.55, ANTVI/ANTIII 1.16–1.39, ANTV/ANTIII 0.63–0.71, ANTIV/ANTIII 0.64–0.74, PT/ANTIII 0.94–1.14, PT/ANTIV 1.37–1.59, PT/ANTV 1.40–1.70. LHANTIII 0.025–0.032 mm long, 0.80–1.04 × BDANTIII. HW 0.46–0.52 mm, 0.88–1.07 × SIPH. Rostrum passing mid-leg coxa. URS 0.17–0.18 mm, 0.33–0.38 × HW, 0.22–0.26 × ANTIII, 0.18–0.21 × ANTVI, 0.22–0.25 × PT, 1.01–1.13 × ANTVib, 0.31–0.38 × SIPH and 1.41–1.73 × HTII, with 8–9 accessory setae (Fig. 2I). HF 0.83–0.97 mm. HT 1.53–1.77 mm, 0.65–0.80 × BL.



**Figure 1.** Habitus of *Uroleucon carthami* (Hille Ris Lambers, 1948), alate male.

First tarsal segment with 5:5:5 setae. HTII 0.10–0.13 mm,  $0.14\text{--}0.16 \times \text{PT}$  and  $0.62\text{--}0.72 \times \text{ANTVIb}$ . Abdomen membranous, with oval marginal sclerites containing very small marginal tubercles and fine setae with pointed apices. ABDTVIII with (3)4–5 long setae. SIPH with ante- and post-siphuncular sclerites (Fig. 2F). SIPH 0.47–0.58 mm, tubular, slightly tapering, with subapical reticulation covering 15–21% of the distal length of SIPH (Fig. 2H). SIPH  $2.18\text{--}2.70 \times \text{Cauda}$ ,  $0.20\text{--}0.25 \times \text{BL}$ ,  $0.67\text{--}0.76 \times \text{ANTIII}$ ,  $0.64\text{--}0.81 \times \text{PT}$ ,  $2.64\text{--}3.22 \times \text{URS}$ ,  $4.21\text{--}5.02 \times \text{HTII}$  and  $0.94\text{--}1.13 \times \text{HW}$ . Cauda long-triangular, 0.17–0.24 mm long,  $0.37\text{--}0.48 \times \text{HW}$ ,  $0.99\text{--}1.34 \times \text{URS}$ ,  $0.07\text{--}0.10 \times \text{BL}$ , with (15)17–22 fine long setae mostly on its apex. Parameres long triangular covered with fine, pointed setae. Basal part of phallus as long as or slightly longer than parameres (Fig. 2J).

**Material examined.** ARG00074: Iran, Kerman province, Kohpayeh, alt. 2080 m., on *Carthamus oxyacantha*, 19-V-2006, leg. Mohsen Mehrparvar. ARG00282: Iran, Fars province, Eghlid, alt. 2241 m., on *Carthamus oxyacantha*, 4-VIII-2020, leg. Moein Rokni. ARG00289: Iran, Razavi-Khorasan province, Kashmar, alt. 1053 m., on *Carthamus oxyacantha*, 20-V-2020, leg. Mohammad Mollazadeh. ARG00573: Iran, Kerman province, Mahan, alt. 1908 m., on *Carthamus oxyacantha*, 28-IV-2007, leg. Mohsen Mehrparvar. ARG00575: Iran, Fars province, Estahban, alt. 1902 m., on *Carthamus oxyacantha*, 28-V-2021, leg. Moein Rokni. ARG00576: Iran, Fars province, Bamou National Park, alt. 1760 m., on *Carthamus oxyacantha*, 7-V-2021, leg. Moein Rokni. ARG00578: Iran, Kerman province, Mahan, alt. 1929 m., on *Carthamus oxyacantha*, 17-VI-2015, leg. Mohsen Mehrparvar.



**Figure 2.** Alatae male of *Uroleucon carthami*, morphological details; **A.** Head; **B.** ANTI-III; **C.** ANTIV; **D.** ANTV; **E.** ANTVI including PT and ANTVIb; **F.** Dorsal view of abdomen; **G.** HT; **H.** SIPH; **I.** URS, **J.** Genitalia; **K.** Cauda. Top scale bar for A-F. and down scale bar for G-K.

ARG00574: Iran, Kerman province, Khabr, alt. 2102 m., on *Carthamus lanatus*, 12-V-2016, leg. Moein Rokni. ARG00572: Iran, Kerman province, Shahdad, alt. 492 m., on *Carthamus tinctorius*, 9-III-2007, leg. Mohsen Mehrparvar. ARG00587: Iran, Kerman province, Mahan, alt. 1929 m., on *Carthamus oxyacantha*, VIII-2014, leg. Zahra Gorji. ARG00590: Iran, North Khorasan province, Maneh and Samalqan, alt. 695 m., on *Carthamus lanatus*, 5-IV-2017, leg. Neda Sedighi. ARG00591: Iran, North Khorasan province, Maneh and Samalqan, alt. 846 m., on *Carthamus lanatus*, 5-IV-2017, leg. Neda Sedighi. ARG00592: Iran, Isfahan province, Isfahan-IUT, alt. 1630 m., on *Carthamus tinctorius*, 2014, leg. Zahra Gorji. ARG00595: Iran, Kerman province, Mahan-KGUT, alt. 1929 m., on *Carthamus tinctorius*, 15-X-2014, leg. Zahra Gorji. ARG00596: Iran, Kerman province, Mahan-KGUT, alt. 1929 m., on *Carthamus tinctorius*, 3-XII-2014, leg. Zahra Gorji. ARG00597: Iran, North Khorasan province, Maneh and Samalqan, alt. 644 m., on *Carthamus lanatus*, 26-V-2017, leg. Neda Sedighi. ARG00598: Iran, North Khorasan province, Sisab, alt. 1079 m., on *Carthamus lanatus*, 24-V-2017, leg. Neda Sedighi. ARG00599: Iran, North Khorasan province, Sisab, alt. 1075 m., on *Carthamus lanatus*, 21-V-2017, leg. Neda Sedighi. ARG00602: Iran, Kerman province, Baft, alt. 2066 m., on *Carthamus oxyacantha*, 27-V-2016, leg. Moein Rokni. ARG00603: Iran, Kerman province, Mahan-KGUT, alt. 1929 m., on *Carthamus oxyacantha*, 14-V-2007, leg. Mohsen Mehrparvar.

### ***Uroleucon cichorii* (Koch, 1855)**

Apterae exhibit a shining metallic brown colour with black antennae and siphunculi, complemented by black legs, except for dusky/dark coxae, pale trochanters, and basal halves of femora. Cauda is pale yellow, and their body length ranges from 2.7 to 4.7 mm. These aphids are typically found on the upper parts of stems of *Cichorium* and related genera of Cichorieae. Their distribution spans Europe, southwest and central Asia, Eritrea, Mongolia, Korea, and east Siberia (Blackman & Eastop, 2024). This aphid species has been reported on *Carthamus* in Iran by Hodjat (1993) and Rezwani (1987), yet considering its biology and host association further investigations are required for confirmation.

**Material.** Not examined.

### ***Uroleucon (Uromelan) compositae* (Theobald, 1915)**

Apterae display a glossy, very dark red to almost black colour, featuring black siphunculi and cauda, with a body length ranging from 1.9 to 4.1 mm. These aphids are commonly found on flower stems and, in limited numbers, along the mid-ribs of leaves, predominantly on a diverse array of Asteraceae in tropical and subtropical climates. Particularly, they inhabit plants growing in moist or shady conditions towards the end of the dry season. Notably, this species acts as a pest of cultivated safflower i.e. *Carthamus tinctorius* in India (Blackman & Eastop 2000). Occasionally, it is observed on non-composite plants such as *Malva* and *Morus*. Its distribution spans across Africa, the Indian subcontinent, and it has also been recorded in Sicily, Türkiye, Iran, Réunion, Mauritius, Taiwan, and South America (Blackman & Eastop, 2024). In Iran, this aphid has been reported in some provinces including Alborz, Gilan, Hamedan, Kermanshah, Markazi, Mazandaran and Tehran (Mehrparvar, 2024a).

**Material.** Not examined.

### ***Uroleucon (Uromelan) jaceae* (Linnaeus, 1758)**

Apterae exhibit a dark reddish-brown or blackish-brown colour, often shiny, accompanied by black antennae, siphunculi, and cauda, with a body length ranging from 2.8 to 4.7 mm. These aphids are typically found on the upper parts of stems of *Centaurea* spp., although occasional records exist from other composite genera. There are also sporadic occurrences on certain Boraginaceae. It's worth noting that the name may be applied to a group of closely related species with more specific host associations. This species is distributed in Europe, West Siberia, the Middle East, Central Asia, and Pakistan (Blackman & Eastop, 2024). This aphid has been documented in various provinces across Iran, including Alborz, Fars, Gilan, Kerman, Markazi, Mazandaran, North Khorasan, Tehran, West Azerbaijan, and Zanjan. However, its presence on *Carthamus* is currently limited to Fars province

(Goodarzifar et al., 2010). This is the first report of this aphid species from Isfahan province. The populations of this species on *Carthamus* closely resemble those of *U. carthami*; for more details, refer to the section below on *U. carthami* in this article.

**Material examined.** ARG00577: Iran, Kerman province, Mahan, alt. 1929 m., on *Carthamus tinctorius*, 1-X-2014, leg. Mohsen Mehrparvar. ARG00579: Iran, Isfahan province, Lavark, on *Carthamus tinctorius*, 31-VIII-2005, leg. Unknown. ARG00584: Iran, Kerman province, Mahan, alt. 1934 m., on *Carthamus oxyacantha*, 6-V-2015, leg. Mohsen Mehrparvar. ARG00585: Iran, Isfahan province, Isfahan-IUT, on *Carthamus tinctorius*, 10-XII-2002, leg. Mohsen Mehrparvar. ARG00593: Iran, Isfahan province, Isfahan-IUT, alt. 1630 m., on *Carthamus tinctorius*, 10-XI-2003, leg. Mohsen Mehrparvar. ARG00600: Iran, Kerman province, Bongana, alt. 2582 m., on *Carthamus tinctorius*, 30-IX-2017, leg. Moein Rokni.

## Subfamily Lachninae Herrich-Schaeffer, 1854

### Tribe Tramini Herrich-Schaeffer, 1854

#### *Protrama radialis* (Kaltenbach, 1843)

Apterae exhibit a colour range from dirty white to pale yellow or pale brownish-green, accompanied by brown siphuncular cones, with a body length spanning from 2.5 to 3.4 mm. The majority of apterae show some degree of alatiform characteristics, while true alatae remain undiscovered. These aphids form colonies attended by ants on the roots of various Asteraceae within the Cynareae subfamily (Blackman & Eastop, 2024). This species is documented in Europe (excluding the Iberian peninsula), as well as in southwest and central Asia (Blackman & Eastop, 2024). This aphid species has a wide distribution in Iran, but its occurrence on *Carthamus* is only reported by Hodjat (1993)(p. 100), without specifying the locality.

**Material.** Not examined.

#### Suspicious records

***Amphorophora* sp.** Rezwani (1987) reported *Amphorophora* sp. on *C. tinctorius* in Varamin, Tehran province. The genus *Amphorophora* encompasses approximately 27 species primarily associated with *Rubus*, ferns, and a limited number of plants within the Rosaceae family. However, none of these species has been documented on any plants belonging to the Asteraceae family (Blackman & Eastop, 2024). Hence, the likelihood of a species from this genus being present on *Carthamus* is highly improbable. This report could potentially stem from misidentification or the inadvertent mixing of aphid samples during the collection process.

***Macrosiphoniella* sp.** Sedighi et al. (2020) in their paper indicated the presence of a *Macrosiphoniella* species on *Carthamus lanatus* in North Khorasan province. As of now, no reports exist of any species belonging to this genus on *Carthamus* globally (Blackman & Eastop, 2024), even though *Macrosiphoniella* aphids mostly colonize plants within the Asteraceae family. Further comprehensive investigations are essential in this regard.

***Pleotrichophorus glandulosus* (Kaltenbach, 1846).** Apterae exhibit a yellowish-white colour, occasionally with a pale green median stripe, and sometimes appear greenish; their body length ranges from 1.4 to 2.6 mm. They are typically found on the undersides of lower leaves of *Artemisia vulgaris* and occasionally on other *Artemisia* spp. However, Rezwani (2010) in his book reported this aphid species on *C. tinctorius* from Tehran. According to Blackman & Eastop (2024), records on plants from genera other than *Artemisia* are deemed likely to involve vagrants or stem from potential misidentifications. This species is distributed across Europe and throughout Asia to Japan, China, Korea, and Taiwan, with introductions to eastern North America. It is also present in Argentina and Uruguay (Blackman & Eastop, 2024). In Iran, this aphid was reported from Guilan, Mazandaran and Tehran provinces (Mehrparvar, 2024a).

**Table 1.** Aphid species living on *Carthamus* spp. (Asteraceae) in Iran based on specimens in the ARG collection and/or already published resources. The distribution of aphid species in the table is limited to reports on *Carthamus* in Iran. New host plants and new distribution in Iran are marked by an asterisk [\*].

| Aphid species  | Host plant  | Distribution   | Reference  |
|--|---|--|--|
| <i>Acyrtosiphon ilka ilka</i> Mordvilko, 1914                  | <i>Carthamus oxyacantha</i><br><i>Carthamus tinctorius</i>  | West Azerbaijan  | (Rezwani et al., 1994; Rezwani, 2010)  |
| <i>Amphorophora</i> sp.  | <i>Carthamus tinctorius</i>   | Tehran   | (Rezwani, 1987)  |
| <i>Aphis fabae</i> Scopoli, 1763                               | <i>Carthamus oxyacantha</i><br><i>Carthamus</i> sp.<br><i>Carthamus tinctorius</i>  | Isfahan<br>Kermanshah  | (Samii, 1992; Hodjat, 1993; Rezwani, 2010; Ghahramani Nezhad et al., 2012)   |
| <i>Aphis solanella</i> Theobald, 1914                          | <i>Carthamus lanatus</i><br><i>Carthamus tinctorius</i>   | Fars<br>Sistan and<br>Baluchestan  | (Goodarzifzar, 2010; Goodarzifzar et al., 2010); Bameri Din, 2020)   |
| <i>Brachycaudus (Prunaphis) cardui</i> (Linnaeus, 1758)        | <i>Carthamus lanatus</i>  | North Khorasan   | (Sedighi, 2019; Sedighi et al., 2020)  |
| <i>Brachycaudus helichrysi</i> (Kaltenbach, 1843)              | <i>Carthamus lanatus</i><br><i>Carthamus</i> sp.<br><i>Carthamus tinctorius</i> *   | Fars<br>Kerman   | (Goodarzifzar, 2010; Goodarzifzar et al., 2010)  |
| <i>Capitophorus elaeagni</i> (Del Guercio, 1894)               | <i>Carthamus lanatus</i>  | Fars   | (Goodarzifzar, 2010; Goodarzifzar et al., 2010)  |
| <i>Macrosiphoniella</i> sp.                                    | <i>Carthamus lanatus</i>  | North Khorasan   | (Sedighi et al., 2020)   |
| <i>Myzus (Nectarosiphon) persicae</i> (Sulzer, 1776)           | <i>Carthamus lanatus</i><br><i>Carthamus oxyacantha</i><br><i>Carthamus</i> sp.<br><i>Carthamus tinctorius</i>                              | Fars<br>Kermanshah   | (Hodjat, 1993; Goodarzifzar, 2010; Rezwani, 2010; Ghahramani Nezhad et al., 2012)  |
| <i>Pleotrichophorus glandulosus</i> (Kaltenbach, 1846)         | <i>Carthamus tinctorius</i>   | Tehran   | (Rezwani, 2010)  |
| <i>Protaphis anuraphoides</i> (Nevsky, 1928)                   | <i>Carthamus oxyacantha</i><br><i>Carthamus tinctorius</i>  | West Azerbaijan  | (Rezwani, 1990; Rezwani & Parvizi, 1990); Rezwani et al., 1994; Rezwani, 2010; Momeni Shahraki et al., 2019)   |
| <i>Protaphis carthami</i> (Das, 1918)                          | <i>Carthamus oxyacantha</i><br><i>Carthamus</i> spp.<br><i>Carthamus tinctorius</i>   | Alborz<br>Fars<br>Kerman<br>Razavi Khorasan*   | (Blackman & Eastop, 2006; Rezwani, 2010; Mehrparvar & Pourtaghi, 2017; Rokni, 2018; Momeni Shahraki et al., 2019; Mehrparvar et al., 2021, 2022)   |
| <i>Protaphis pseudocardui</i> (Theobald, 1915)                 | <i>Carthamus oxyacantha</i><br><i>Carthamus</i> sp.<br><i>Carthamus tinctorius</i>  | Razavi Khorasan<br>Tehran  | (Hodjat, 1993; Rezwani et al., 1994; Rezwani, 2010; Mortazavi et al., 2015)  |
| <i>Protrama radialis</i> (Kaltenbach, 1843)                    | <i>Carthamus</i> sp.  |  | (Hodjat, 1993)   |
| <i>Uroleucon (Uromelan) carthami</i> (Hille Ris Lambers, 1948) | <i>Carthamus dentatus</i><br><i>Carthamus lanatus</i><br><i>Carthamus oxyacantha</i><br><i>Carthamus</i> sp.<br><i>Carthamus tinctorius</i> | Alborz<br>Fars<br>Isfahan*<br>Kerman<br>Markazi<br>North Khorasan<br>Razavi Khorasan<br>Sistan and<br>Baluchestan<br>Tehran<br>West Azerbaijan | (Rezwani, 1987; Hodjat & Ahmadian Tehrani, 1988; Rezwani & Parvizi, 1990; Rezwani, 1991; Hodjat, 1993; Rezwani et al., 1994; Goodarzifzar, 2010; Goodarzifzar et al., 2010; Rezwani, 2010; Mehrparvar & Pourtaghi, 2017; Rokni, 2018; Momeni Shahraki et al., 2019; Sedighi, 2019; Bameri Din, 2020; Sedighi et al., 2020; Mehrparvar et al., 2021; Molazadeh Bagh Seyah, 2021; Mehrparvar et al., 2022) |
| <i>Uroleucon cichorii</i> (Koch, 1855)                         | <i>Carthamus oxyacantha</i>   | Alborz<br>Tehran<br>West Azerbaijan  | (Rezwani, 1987; Hodjat, 1993; Momeni Shahraki et al., 2019)  |
| <i>Uroleucon (Uromelan) compositae</i> (Theobald, 1915)        | <i>Carthamus tinctorius</i>   | Tehran<br>Markazi<br>Hamedan   | (Hodjat & Ahmadian Tehrani, 1988; Rezwani, 1991; Rezwani et al., 1994; Alikhani et al., 2010; Rezwani, 2010)   |
| <i>Uroleucon (Uromelan) jaceae</i> (Linnaeus, 1758)            | <i>Carthamus oxyacantha</i> *<br><i>Carthamus</i> sp.<br><i>Carthamus tinctorius</i>  | Fars<br>Isfahan*<br>Kerman   | (Hodjat & Ahmadian Tehrani, 1988; Hodjat, 1993; Goodarzifzar, 2010; Goodarzifzar et al., 2010; Rezwani, 2010)  |

### Key to the apterous viviparous females of aphid species living on *Carthamus* spp. in Iran

- 1 PT/ANTVIb less than 0.7. SIPH as pores placed on flat cones. Body and appendages densely hairy. Hind tarsus elongate, more than  $0.7 \times$  hind tibia. .... *Protrama radialis* (Kaltenbach, 1843)
- PT/ANTVIb more than 0.7. SIPH tubular or conical. Body and appendages not densely hairy. Hind tarsus normal. .... 2
- 2 SIPH dark, with polygonal reticulation. .... 3
- SIPH pale or dark but without polygonal reticulation. .... 7
- 3 First tarsal segments with 3 setae. Polygonal reticulation covers more than 40% of SIPH distal part. .... *Macrosiphoniella* sp.
- First tarsal segments with 5 setae. Polygonal reticulation covers about 10–40% of SIPH distal part. .... 4
- 4 Cauda pale. Crescent-shaped antesiphuncular sclerites present. .... *Uroleucon cichorii* (Koch, 1855)
- Cauda dark. Antesiphuncular sclerites absent. .... 5
- 5 ANTIII  $1.8\text{--}2.5 \times$  ANTV, with 42–86 rhinaria extending over 0.68–0.95 of length. SIPH with reticulation over distal 25–32%. PT/ANTVIb 5.2–7.3 (mostly 5.5–7.0). ABDTII–IV without marginal tubercles. .... *Uroleucon compositae* (Theobald, 1915)
- ANTIII  $1.4\text{--}1.9 \times$  ANTV, with 15–55(61) rhinaria extending over 0.45–0.68 of length. SIPH with reticulation over distal 16–27%. PT/ANTVIb 4.0–6.6 (mostly 4.5–5.5). ABDTII–IV mostly with small marginal tubercles. .... 6
- 6 URS  $0.89\text{--}1.22 \times$  ANTVIb. ANTIII with 21–55(61) rhinaria, few of which exceed  $10 \mu\text{m}$  in diameter. Mainly on *Carthamus tinctorius*. .... *Uroleucon jaceae* (Linnaeus, 1758)
- URS  $(0.99)1.01\text{--}1.4 \times$  ANTVIb. ANTIII with 15–39(49) rhinaria, many of which exceed  $10 \mu\text{m}$  in diameter. Mainly on wild *Carthamus*. .... *Uroleucon carthami* (Hille Ris Lambers, 1948)
- 7 ANT tubercles well-developed. .... 8
- ANT tubercles undeveloped or less developed. .... 12
- 8 Head ornamented with numerous spicules. ANT tubercles with inner faces scabrous and almost parallel. Distal half of SIPH with some degree of swelling. .... *Myzus persicae* (Sulzer, 1776)
- Head smooth without spicules. ANT tubercles with inner faces divergent. .... 9
- 9 SIPH with slight to moderate swelling on distal half. .... *Amphorophora* sp. (see text)
- SIPH without swelling. .... 10
- 10 Hairs on front of head shorter than BDANTIII, with blunt or pointed apices. Dorsal hairs short, inconspicuous. .... *Acyrtosiphon ilka ilka* Mordvilko, 1914
- Hairs on front of head longer than BDANTIII, with distinctly expanded apices. .... 11
- 11 ANTIII without rhinaria. URS with pointed apex. SIPH with dark apices,  $1.5\text{--}1.8 \times$  ANTIII. .... *Capitophorus elaeagni* (Del Guercio, 1894)
- ANTIII with rhinaria. URS stiletto-shaped. SIPH without dark apices and shorter than ANTIII. .... *Pleotrichophorus glandulosus* (Kaltenbach, 1846) (see text)
- 12 PT/ANTVIb 0.7–1.2. URS longer than PT. SIPH short,  $0.62\text{--}1.2 \times$  cauda, which is either helmet-shaped or bluntly triangular. .... 13
- PT/ANTVIb more than 1.5. URS much shorter than PT. SIPH usually longer than cauda, which is helmet-, tongue- or finger-shaped. .... 15
- 13 SIPH  $0.50\text{--}0.76 \times$  URS, and  $0.56\text{--}0.87 \times$  cauda. LHABDTIII  $1.2\text{--}1.8 \times$  BD ANTIII. .... *Protaphis carthami* (Das, 1918)
- SIPH  $0.7\text{--}0.9 \times$  URS and  $0.88\text{--}1.2 \times$  cauda. LHABDTIII  $0.7\text{--}1.3 \times$  BDANTIII. .... 14
- 14 ANTIII usually without secondary rhinaria (rarely with 1–3). URS  $1.28\text{--}1.36 \times$  HTII. LHABDTIII  $0.7\text{--}1.1 \times$  BDANTIII. .... *Protaphis pseudocardui* (Theobald, 1915)
- ANTIII usually with (1–10) secondary rhinaria. URS  $1.45\text{--}1.65 \times$  HTII. LHABDTIII  $1.2\text{--}1.3 \times$  BDANTIII. .... *Protaphis anuraphoides* (Nevsky, 1928)

- 15 Cauda helmet-shaped, with slight basal constriction, a little shorter than its basal width in dorsal view, and bearing 4–8 hairs. Spiracular apertures large and rounded. .... 16
- Cauda tongue- or finger-shaped, longer than its basal width. Spiracular apertures reniform. .... 17
- 16 Abdomen with an extensive dark dorsal shield. SIPH dark, imbricated, 1.7–3.4 × cauda. Mesosternum with a pair of dark mammariform processes. ANTIII 0.30–0.47 mm, 2.4–3.4 × HTII. URS 0.17–0.24 mm. .... *Brachycaudus cardui* (Linnaeus, 1758)
- Abdomen without dark markings. SIPH pale, smooth, 0.8–2.1 × cauda. Mesosternum without mammariform processes. ANTIII 0.07–0.30 mm, 0.9–2.8 × HTII. URS 0.10–0.15 mm. .... *Brachycaudus helichrysi* (Kaltenbach, 1843)
- 17 SIPH 2.4–5.4 × longest marginal hair on ABDTI-III. LHANTIII 17–69 μm (mostly 35–60 μm); LHHF 45–100 μm (mostly 70–90 μm). SIPH 2.8–5.1 × their diameter at midlength, 0.8–1.6 × cauda and 0.08–0.17 × BL. URS 0.85–1.13 × HTII. PT/ANTVIb (1.8–)2.1–3.4(–3.8). .... *Aphis fabae* Scopoli, 1763
- SIPH 5.4–17.0 × longest marginal hair on ABDTI-III. LHANTIII 15–35 μm (mostly 20–30 μm). LHHF 45–75 (–82) μm. SIPH 3.5–7.5 × their diameter at midlength, 1.3–2.0 × cauda and 0.13–0.20 × BL. URS (0.98–)1.03–1.30 × HTII. PT/ANTVIb 2.8–4.1. .... *Aphis solanella* Theobald, 1914

## DISCUSSION

Aphid species associated with *Carthamus* plants in Iran exclusively belong to the family Aphididae, further classified into two subfamilies: Aphidinae and Lachninae. Within these subfamilies, they are categorized into three tribes—Aphidini, Macrosiphini and Trimini. The predominant genus is *Uroleucon*, comprising four species, primarily specialized on host plants of the family Asteraceae. Amongst the identified aphid species, five species exhibit polyphagous behaviour, feeding on various host plant families. Based on the species identified in this study, it was determined that one of these is newly recorded in Razavi Khorasan province, and two species are newly documented in Isfahan province (Table 1). In Iran, the diversity of aphid species would likely be influenced by the country's diverse climatic and ecological conditions. Different regions with varying climates and vegetation may support different aphid species and populations. Aphids have a wide range of host plants and interactions with other organisms, making them an integral part of ecosystems.

The findings of this research not only contribute to the knowledge base of aphid diversity but also have practical implications for sustainable safflower cultivation in Iran. Additionally, the discovery of previously unknown sexual morph adds a valuable dimension to the understanding of the life history and reproductive biology of *U. carthami*, further enriching our comprehension of the aphid ecology. Apterous and then alate viviparous females of aphids represent the most familiar morphs in the description of nearly every aphid species. Conversely, the sexual morphs, encompassing oviparous females and males, remain inadequately known or, in many instances, entirely undiscovered, with rare instances of collection and description. Despite their infrequent occurrence, the significance of the sexual generation has been substantiated in enhancing our understanding of the overall biology of lesser-known species. Additionally, it plays a pivotal role in resolving taxonomic issues and advancing our comprehension of the evolutionary aspects of aphids (Kanturski & Lee, 2020). In contributing to the scientific understanding of aphid taxonomy and morphology, our research addresses this knowledge gap by providing a detailed description of the alate male of *U. carthami*, a particular aphid species associated with *Carthamus* (safflower), and shedding light on the reproductive strategies and life history of this particular species.

This is acknowledged that the populations of Iranian *U. carthami* and *U. jaceae* exhibit striking similarities and share overlapping characteristics. In this paper, we have only reported the samples, as a distinct species, that we were able to identify based on existing distinguishing characteristics, ensuring our confidence in their identification including the sample that includes males. There are several other samples that exhibit the aforementioned overlap, which we have chosen not to include in the paper as a distinct species. We intend to conduct further morphometric and molecular analyses on these samples in the future to elucidate their differences, but these materials are not presented in this paper.

## AUTHOR'S CONTRIBUTION

The authors confirm their contribution to the paper as follows: M. Mehrparvar: collecting, preparation, sorting of the material, identification of aphid specimens, writing and revising the manuscript; S.M. Mirtadjadini: identification of plant species and participating in revising the manuscript. Both authors read and approved the final version of the manuscript.

## FUNDING

This work is based upon research funded by Iran National Science Foundation (INSF) under project No. 4015303.

## AVAILABILITY OF DATA AND MATERIAL

The specimens examined in this study are deposited in the Aphidology Research Group collection, Kerman, Iran, and are available by the curator upon request.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

## CONSENT FOR PUBLICATION

Not applicable.

## CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this paper.

## ACKNOWLEDGMENTS

We would like to express our gratitude to Miss S. M. Injoo for her valuable assistance in laboratory work and to anonymous reviewers for their valuable comments.

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## شته‌های مرتبط با گیاهان جنس گلرنگ در ایران به همراه توصیف فرم جنسی نر گونه *Uroleucon carthami* (Hemi.: Aphididae) (Hille Ris Lambers, 1948)

محسن مهرپرور<sup>۱\*</sup> و منصور میرتاج‌الدینی<sup>۲</sup>

- ۱- دانشگاه تحصیلات تکمیلی صنعتی و فناوری پیشرفته، پژوهشگاه علوم و تکنولوژی پیشرفته و علوم محیطی، گروه تنوع زیستی، کرمان، ایران.
- ۲- دانشگاه شهید باهنر کرمان، دانشکده علوم، گروه زیست‌شناسی، کرمان، ایران.

\* پست الکترونیک نویسنده مسئول مکاتبه: [mehrparvar@kgut.ac.ir](mailto:mehrparvar@kgut.ac.ir)

تاریخ دریافت: ۲۰ بهمن ۱۴۰۲ | تاریخ پذیرش: ۱۲ فروردین ۱۴۰۳ | تاریخ انتشار: در حال چاپ |

**چکیده:** شته‌ها گروه مهمی از حشرات گیاه‌خوار را تشکیل می‌دهند که از شیر گیاهی تغذیه می‌کنند و از این رو تهدید قابل توجهی برای سلامت گیاهان به شمار می‌روند. در این مقاله به بررسی جامع فون شته‌های مرتبط با گلرنگ (جنس *Carthamus*) در ایران پرداخته و ۱۸ گونه در ۱۱ جنس از خانواده Aphididae را معرفی می‌کنیم که در این بین سه رکورد جدید از گونه شته‌ها برای استان‌های اصفهان و خراسان رضوی گزارش می‌گردد. همچنین در این مطالعه ۳۱ ارتباط بین گونه‌های شته و گیاهان میزبان شناسایی شد که دو مورد از آنها برای ایران جدید هستند. علاوه بر این، جنس نر گونه *Uroleucon carthami* نیز توصیف شده است که اطلاعات جدیدی در رابطه با چرخه زندگی و استراتژی‌های تولیدمثلی آن ارائه می‌دهد. کلید شناسایی شته‌های ماده بکرزا بی بال مربوط به گیاهان جنس گلرنگ در ایران نیز ارائه شد.

**واژگان کلیدی:** فون، طبقه‌بندی، گلرنگ، پراکنش، فرم جنسی