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Research Article

Jumping plant-lice (Hem., Psylloidea) of sea buckthorn (*Hippophae rhamnoides*): Updated species list and a new record from Iran

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Abstract. Currently, 44 psyllid species are known to be associated with *Hippophae rhamnoides* worldwide. Despite this diversity, only *Cacopsylla nasuta* (Förster, 1848) has previously been recorded from Iran. *Cacopsylla zetterstedti* (Thomson, 1877) is reported here for the first time from Iran. In addition, an updated list of all psyllid species associated with *H. rhamnoides* is provided, along with an identification key for the species occurring in Iran. A geometric morphometric analysis of the forewing was conducted to examine diagnostic differences between the two studied species. This new record substantially expands the known distribution of *C. zetterstedti* in Asia.

Keywords: *Cacopsylla*, Psyllidae, Triozidae, Geometric morphometric, Iran

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Introduction

Sea-buckthorn, *Hippophae rhamnoides* (Elaeagnaceae), is a deciduous, dioecious shrub that primarily distributed in temperate regions. The native range of this species extends from Europe to southern Siberia and south-central China (POWO, 2025). Currently, seven infraspecific are recognized within this species (POWO, 2025). In Iran, *H. rhamnoides* is considered one of the characteristic species of the Irano-Turanian phytogeographical region, occurring in areas such as Gachsar, Haraz, Arasbaran, Khoy, and Alamut (Aslani *et al.*, 2023). Sea-buckthorn has significant ecological and economic importance. It is widely used for soil erosion control (Cireasa, 1986), land reclamation (Schroeder, 1990), wildlife habitat improvement and farmstead protection (Pearson & Rogers, 1962). Moreover, it possesses high nutritional and medicinal value for humans (Li and Schroeder, 1996). Recent studies have highlighted its diverse pharmacological properties, including anticancer, anti-inflammatory, antimicrobial, and antiviral activities, as well as cardioprotective effects (Aslani *et al.*, 2023). Sea buckthorn hosts a rich fauna of jumping plant-lice (Psylloidea) in the world. Jumping plant-lice, or psyllids, are small phloem-feeding insects belonging to the sternorrhynchous Hemiptera. To date, nearly 4,000 psyllid species have been described from all biogeographic regions of the world (Burckhardt & Queiroz, 2020). A total of 44 psyllid species have been recorded on *H. rhamnoides* worldwide (Table 1). These 44 species belong to the families Psyllidae (Psyllinae: *Cacopsylla* Ossiannilsson and *Psylla* Geoffroy) and Triozidae (*Bactericera* Puton, *Hippophaetrioza* Conci & Tamanini, *Trioza* Foerster, and *Trisetitrioza* Li). Among them, seven species — *Cacopsylla hippophaes* (Förster, 1848), *Cacopsylla nasuta* (Horváth, 1904), *Cacopsylla zetterstedti* (Thomson, 1877), *Psylla lucida* Baeva, 1969, *Psylla pamirica* Baeva, 1969, *Psylla unica* Baeva, 1978, and *Psylla vulpis* Loginova, 1964 — were described from Central Asia (Baeva 1969, 1978, 1985; Gegechkori & Loginova 1990; Loginova, 1964). In Iran, *C. nasuta* has been reported on *H. rhamnoides* by Lashkari *et al.* (2022), who suggested that its distribution is restricted to the mountain ranges of Iran, Central Asia, Siberia, and possibly the Caucasus. The other psyllid feeding on sea buckthorn, *C. zetterstedti*, which is recorded here for the first time from Iran, belongs to the same species group. It is univoltine (Ossiannilsson, 1992) and probably overwinters in the egg stage (Ossiannilsson, 1992) or in the adult stage (Klimaszewski, 1975; Loginova, 1968).

Table 1. Psyllid species feeding on sea buckthorn, *Hippophae rhamnoides* L., worldwide.

	Psyllid species	Distribution
	Family: Psyllidae	
1	*Cacopsylla aurantia* Li, 2005	China (Shaanxi and Gansu) (Li, 2005)
2	*Cacopsylla bomihippophaes* (Li & Yang, 1988)	China (Tibet) (Li & Yang, 1988)
3	*Cacopsylla dichohippophae* (Li, 2011)	China (Shanxi) (Li, 2011)
4	*Cacopsylla gracilenta* Li, 1990	China (Shanxi, Ningxia, Gansu and Sichuan) (Li, 1990; Li, 2011)
5	*Cacopsylla graciscapa* Li, 2011	China (Gansu Shanxi and Ningxia) (Li, 2011)
6	*Cacopsylla guangwui* Li, 2011	China (Shanxi) (Li, 2011)
7	*Cacopsylla hippophaës* (Förster, 1848)	Austria (Low, 1877, based on the material in Hyden's collection), Belarus (Serbina *et al.*, 2015), Caucasus (Gegechkori, 1966; Gegechkori & Loginova, 1990), Czech Republic (Lauterer, 1982), Denmark (Ossiannilsson, 1992), England (Low, 1877, based on the material collected by J. Scott; Hodkinson & White, 1979), Egypt (Samy, 1972), France (Ossiannilsson, 1992), Ireland (O'Connor & Malumphy, 2011), Kazakhstan (Loginova, 1968), Netherlands (Föerster, 1848, as *Psylla hippophaes* based on the Heyden's collection), Poland (Enderlein, 1906), Sweden (Ossiannilsson, 1992), Switzerland (Schäfer, 1949), Turkey (Burckhardt & Önuçar, 1993).
8	*Cacopsylla hui* (Li & Yang, 1987)	China (Tibet) (Li & Yang, 1987)
9	*Cacopsylla jinaphippophae* Li, 2011	China (Shanxi) (Li, 2011)
10	*Cacopsylla latihippophae* Li, 1997	China (Gansu) (Li, 1997)
11	*Cacopsylla longicornis* Li & Yang, 1992	China (Sichuan) (Li & Yang, 1992)
12	*Cacopsylla macroscalpra* Li, 2011	China (Tibet) (Li, 2011)
13	*Cacopsylla magnisalignea* Li, 2011	China (Shanxi, Ningxia and Gansu) (Li, 2011)
14	*Cacopsylla mucronulata* Li, 2011	China (Tibet) (Li, 2011)
15	*Cacopsylla mutilata* Li, 1997	China (Gansu) (Li, 1997)
16	*Cacopsylla nasuta* (Horváth, 1904)	Afghanistan (Malenovský *et al.*, 2012), Iran (Lashkari *et al.*, 2022), Kyrgyzstan (Horváth, 1904), Tadzhikistan (Baeva & Kankina, 1971)
17	*Cacopsylla serpentina* Li & Yang, 1992	China (Sichuan and Shanxi) (Li & Yang, 1992)
18	*Cacopsylla septmimaculata* Li, 2011	China (Tibet) (Li, 2011)
19	*Cacopsylla terminigra* Li, 2011	China (Tibet) (Li, 2011)
20	*Cacopsylla tingriana* (Li & Yang, 1987)	China (Tibet) (Li & Yang, 1987)
21	*Cacopsylla vulgahippophaes* (Li & Yang, 1987)	China (Tibet) (Li & Yang, 1987)
22	*Cacopsylla wutaishanica* Li, 2011	China (Shanxi) (Li, 2011)
23	*Cacopsylla xibuensis* Li, 2011	China (Shanxi, Shaanxi, Gansu, Ningxia and Sichuan) (Li, 2011)
24	*Cacopsylla zetterstedti* (Thomson, 1877)	Austria (Löw, 1879, as *Psylla phaeoptera*), Czechoslovakia (Lauterer, 1982), Denmark (Ossiannilsson, 1992), France (Ouvrard *et al.*, 2015), Georgia (Loginova, 1968), Italy (Conci & Tamanini, 1984), Germany (Ossiannilsson, 1992), Great Britain (Hodkinson & White, 1979), Netherland (Lauterer & Malenovský, 2002), Norway (Thomson, 1877, as *Chermes zetterstedti*), Poland (Ossiannilsson, 1992), Russia (Altay) (Labina, 2008), Sweden (Ossiannilsson, 1992), Switzerland (Löw, 1879; Schaefer, 1949, as *Psylla phaeoptera*), Tadzhikistan, Uzbekistan and Kyrgyzstan (Baeva, 1985), Turkey (Burckhardt & Önuçar, 1993). **New for Iran.**
25	*Cacopsylla zhamogihippophaes* Li, 2011	China (Tibet) (Li, 2011)
26	*Psylla hippophae* Li, 2011	China (Tibet) (Li, 2011)
27	*Psylla lucida* Baeva, 1969	Kyrgyzstan (Baeva, 1969)
28	*Psylla pamirica* Baeva, 1966	Kyrgyzstan and Tadzhikistan (Baeva, 1969)
29	*Psylla unica* Baeva, 1978	Kyrgyzstan (Baeva, 1978)
30	*Psylla vulpis* Loginova, 1964	Kazakhstan (Loginova, 1964)
	Family: Triozidae	
31	*Bactericera frigeiarea* Li, 2011	China (Tibet) (Li, 2011)
32	*Bactericera rhabdoclada* Li, 2011	China (Tibet) (Li, 2011)
33	*Bactericera xanthogena* (Li & Yang, 1992)	China (Gansu, Ningxia, Sichuan) (Li & Yang, 1992)
34	*Hippophaetrioza chinensis* Li & Yang, 1990	China (Shanxi, Ningxia, Shaanxi and Gansu) (Li & Yang, 1990)
35	*Hippophaetrioza formosa* (Li & Yang, 1990)	China (Tibet) (Li & Yang, 1990)
36	*Hippophaetrioza guangwui* Li & Yang, 1990	China (Shanxi) (Li & Yang, 1990)
37	*Hippophaetrioza incurvata* Li & Yang, 1990	China (Tibet) (Li & Yang, 1990)
38	*Hippophaetrioza maculata* (Li & Yang, 1990)	China (Tibet) (Li & Yang, 1990)
39	*Hippophaetrioza nyingchiensis* Li & Yang, 1990	China (Tibet) (Li & Yang, 1990)
40	*Hippophaetrioza qinghaiensis* Li & Yang, 1990	China (Qinghai) (Li & Yang, 1990)
41	*Hippophaetrioza xizangana* (Li & Yang, 1987)	China (Tibet) (Li & Yang, 1987)
42	*Hippophaetrioza binotata* (Löw, 1883)	Austria (Löw, 1883), Italy (Conci & Tamanini, 1984), Russia (Gegechkori & Loginova, 1990), Switzerland (Burckhardt, 1983)
43	*Trioza tianshanica* Loginova, 1970	Kyrgyzstan (Loginova, 1970)
44	*Trisetitrioza spatulata* (Li, 1993)	China (Tibet) (Li, 1993)

In this study, the psyllids feeding on Sea Buckthorn in Iran—*C. nasuta* and the newly recorded *C. zetterstedti*—are examined with the aim of clarifying their diagnostic morphology and distributional patterns. Geometric morphometric analysis of forewing shape is employed to assess whether wing-shape variation can reliably distinguish the studied species. An updated global list of psyllid species recorded from Sea Buckthorn, *H. rhamnoides*, is also provided.

Materials and methods

The sampling sites were located in mountainous regions in the north of Tehran and Mazandaran provinces during spring and summer 2023POWERF–2024. Adult psyllids were collected using a sweep net and an aspirator. Specimens were preserved in 96% ethanol. The morphological terminology follows Bastin *et al*. (2023). Measurements were taken from both slide-mounted specimens and specimens preserved in ethanol. Plant names follows *Plants of the World Online* (POWO, 2025). Photographs of the specimens were taken using a digital camera attached to the ZEISS (AxioStar) stereomicroscope. For geometric morphometric analysis, the right forewings of *C. nasuta* and *C. zetterstedti* were slide mounted and photographed with a digital camera mounted on a stereomicroscope. Eighteen male specimens per species were used for the analyses. Twenty landmarks (Fig. 2A), including 13 homologous (1, 3, 5, 6, 7, 8, 9, 11, 12, 13, 15, 17 and 19) and seven semi- landmarks (2, 4, 10, 14, 16, 18, 20), were digitized using the tpsDig2 program (Rohlf, 2017). To improve the accuracy of semi-landmarks placement, two parallel lines were drawn at the points of greatest convexity, based on Lashkari *et al*. (2021), with some modifications: one connecting the vein margins and the other parallel to it. Then, a thin-plate spline interpolation (deformation grids) using tpsRelw (Rohlf, 2019) was applied to visualize wing shape changes along the principal components (Figs 2C, 2D). To better understanding of differences, a superimposed mean shape was prepared. A one-way MANOVA was performed in the SAS statistical software to detect any significant differences in wing shape. The examined specimens are deposited in the Department of Biodiversity, Institute of Science and High Technology and Environmental Sciences, Graduate University of Advanced Technology, Kerman (KGUT), Iran.

Results

Class: Insecta Linnaeus, 1758

Order: Hemiptera Linnaeus, 1758

Suborder: Sternorrhyncha Duméril, 1806

Superfamily: Psylloidea Latreille, 1807
Family: Psyllidae Latreille, 1807
Subfamily: Psyllinae Latreille, 1807

Genus: *Cacopsylla* Ossiannilsson, 1970

***Cacopsylla zetterstedti* (Thomson, 1877)**

Chermes zetterstedti Thomson, 1877: 832.

Psylla phaeoptera Löw, 1879: 549; Schaefer, 1949: 46; synonymised by Burckhardt, 1983: 61.

Psylla zetterstedti; Ossiannilsson, 1942: 32.

Cacopsylla zetterstedti (Thomson, 1877); Lauterer, 1982: 140.

Material examined. *Cacopsylla zetterstedti* (Thomson, 1877) — Iran: Tehran, Shemshak, N36°01', E51°46', 2890 m, 3.viii.2023, *H. rhamnoides*, M. Lashkari leg. (KGUT), KGUT: 2 ♂♂, 2 ♀♀ dry and slide mounted, many ♂♂, ♀♀ preserved in 70 % ethanol; Iran: Mazandaran, Kamarbon, N36°13', E51°23', 3.vii.2024, *Hippophae rhamnoides*, M. Lashkari leg. (KGUT), KGUT: 1 ♂, 1 ♀ dry and slide mounted, 5 ♂♂, 5 ♀♀ preserved in 70 % ethanol.

Redescription. Adult. Coloration. Body dirty whitish to dirty-yellowish, with orange and brownish markings (Figs 1A–B). Antennal segments 1–8 yellowish-brown, segments 6–8 dark brown apically, segments 9 and 10 entirely dark brown. Genal processes light yellow or yellowish-orange with darker apex. Compound eyes grey, ocelli reddish-brown. Pronotum yellowish-brown with six light spots. Mesopraescutum yellowish-brown with a light mid-line. Mesoscutum yellowish-brown with six longitudinal light stripes. Legs generally dirty yellow. Forewing transparent with light brown veins. Abdomen yellowish-brown to black; terminalia yellowish brown; tip of paramere and female proctiger dark brown. Structure. Head approximately as wide as the thorax; vertex 0.4–0.5 times as long as broad; genal processes wide at the base, narrowed at the apex, rounded, strongly divergent, almost equal to the length of the vertex along the mid-line, with long setae (Fig. 1C). Antenna 1.5–1.6 times head width; relative length of antennal segment 10 and terminal setae as 1.0 : 1.0 : 1.6 (Fig. 1D).

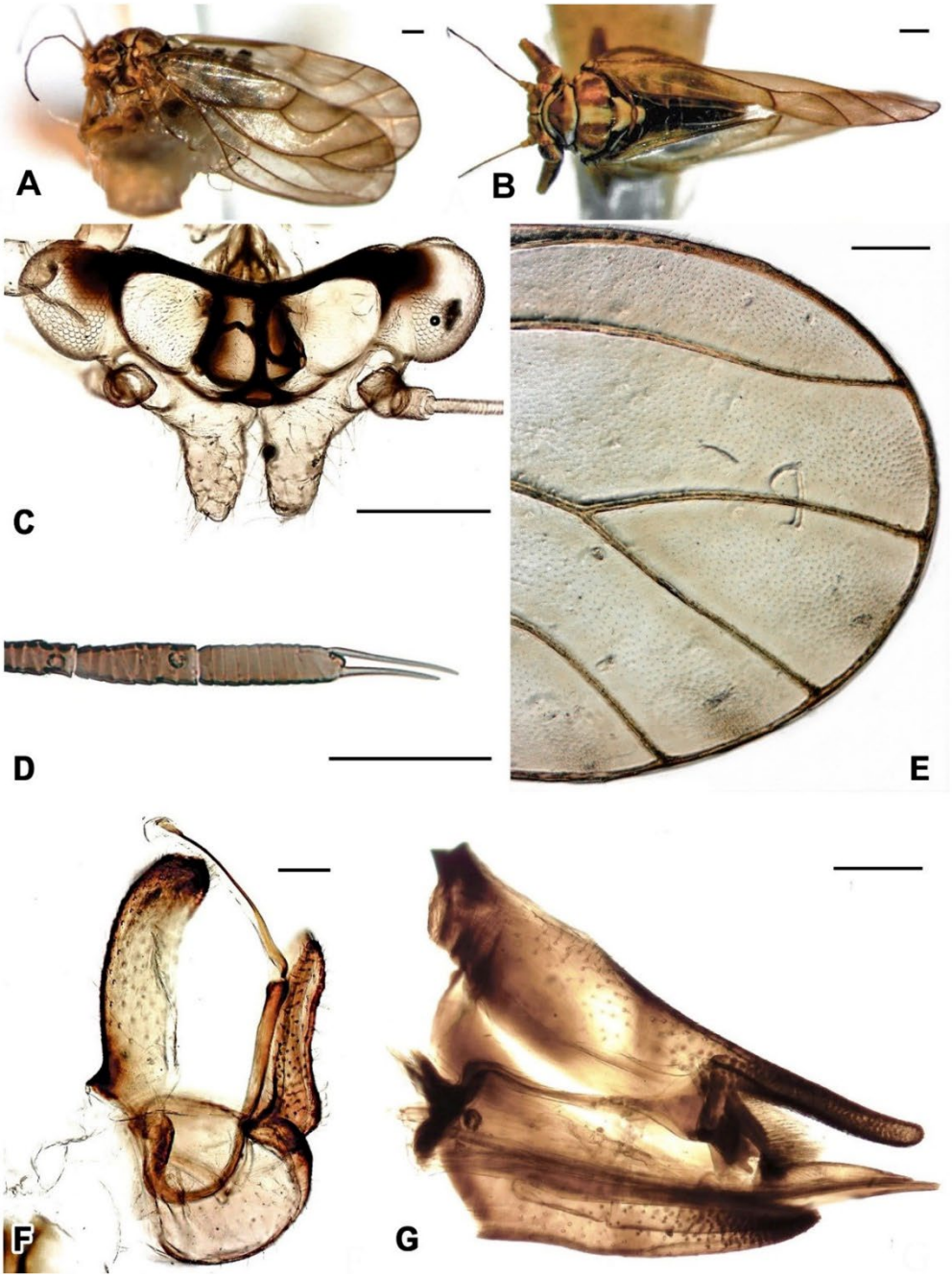

Fig. 1: *Cacopsylla zetterstedti* (Thomson, 1877). A–B, Habitus of male; C, Head, frontal view; D, Antennal segments IX and X and terminal setae; E, Apical half of forewing; F, Male terminalia, lateral view; G, female terminalia, lateral view. Scale bars: 1 mm.

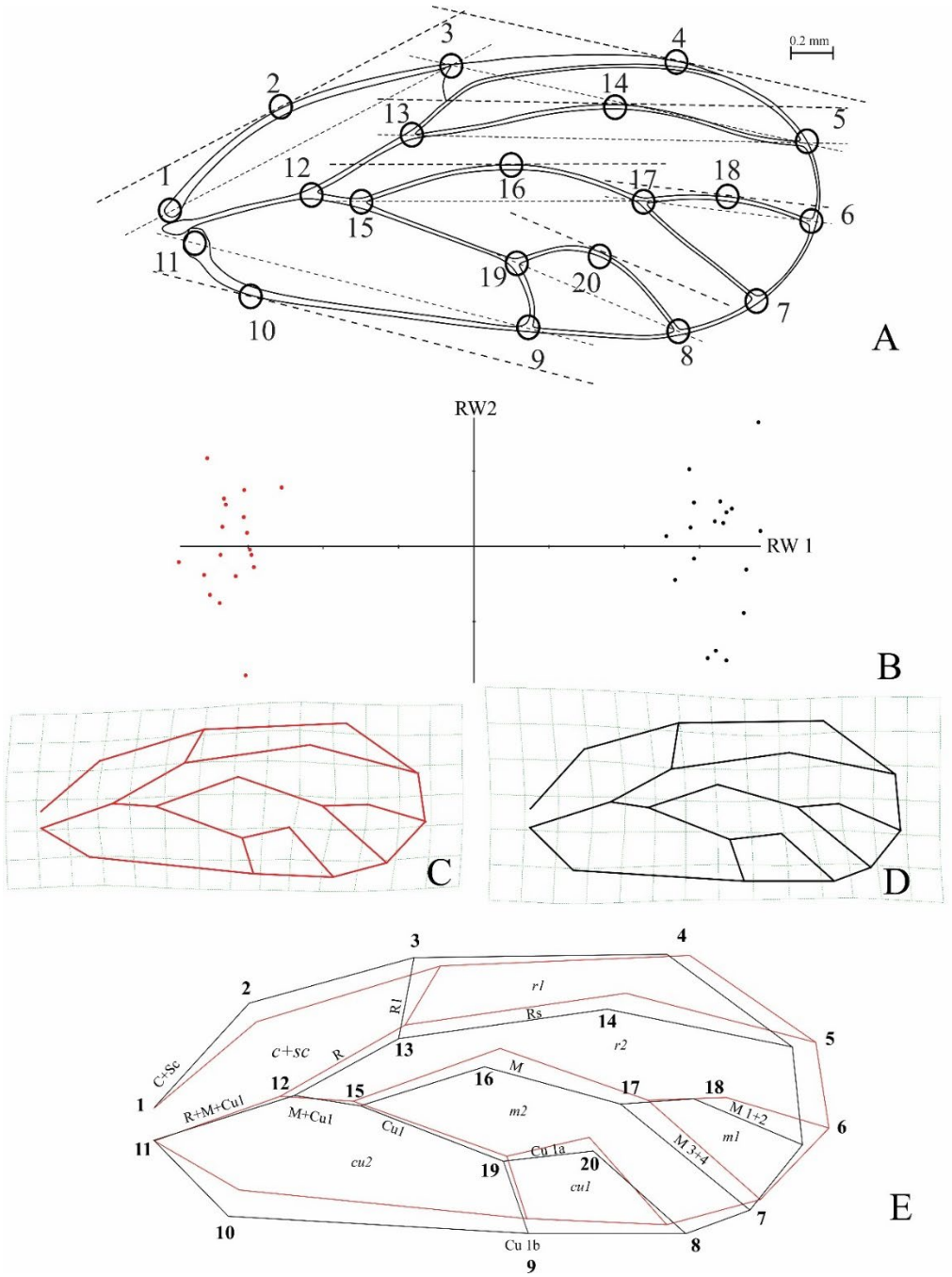

Fig. 2: A, Forewing of *Cacopsylla zetterstedti* with the 20 selected landmarks; B, Plot of the partial warp score matrix; C–D, Mean forewing shapes illustrated by deformation grids, C: *C. nasuta* and D: *C. zetterstedti*; E, Superimposed mean forewing shapes of *C. nasuta* (Red line) and *C. zetterstedti* (Black line).

Metatibia 0.7–0.8 times as long as head width, with well-developed genual spine and five grouped sclerotised apical spurs as 1+3+1. Metabasitarsus with two lateral sclerotised spurs. Forewing membranous, oblong-oval, widest in the apical third, pterostigma narrow, ending at the level of branching point of M., 3.3–3.4 times as long as head width, 2.1–2.2 times as long as broad; cell cu1 longer than high; surface spinules not constricted apically (Fig. 1E). Hindwing shorter than forewing, membranous; costal setae, distal to costal brake, not grouped; veins M and Cu with short common stem. Terminalia as in Figs 1F–G. Male proctiger simple, 0.55–0.57 times as long as head width, moderately to densely beset with long setae. Male subgenital plate subglobular sparsely beset with long setae (Fig. 1F). Paramere slightly shorter than proctiger; digitiform, weakly curved, evenly tapering in apical third, ending in a sclerotized apex (Fig. 1F); beset with long fine setae on outer and inner face. Distal segment of aedeagus slightly shorter than parameres, with relatively rounded apical inflation; apical inflation about one-sixth of the total length of the distal segment (Fig. 1F). Female proctiger 1.4–1.5 times as long as head width, with

weakly wavy dorsal outline, slightly thickened in apical third with narrowly rounded apex; beset with short setae around circumanal ring, long setae in the middle and dense peg setae in apical third (Fig. 1G); proctiger 4–4.5 times as long as circumanal ring, composed of two unequal rows of pores; proctiger 1.3–1.4 times as long as subgenital plate, which is subacute apically; covered with long sparse setae laterally and ventrally, with sparse, short setae laterally and dense peg setae in the apical (Fig. 1G). Dorsal and ventral valvulae slightly curved, lacking teeth.

Immature. Good descriptions are available for the 5th instar nymphs in Ossiannilsson (1970; 1992).

Measurements (in mm): Adult (n = 5 ♂♂, 5 ♀♀): Body length of males 3.20–3.30 mm, females 3.80–3.90 mm. Head width 0.90–0.95; antenna length 1.40–1.50 mm; metatibia length 0.55–0.62; forewing length 3.00–3.20; forewing width 1.40–1.50; male proctiger length 0.50–0.55; female proctiger length 1.30–1.40.

Cacopsylla nasuta (Horváth, 1904)

Material examined. *Cacopsylla nasuta* (Horváth, 1904)—Iran: Tehran, Shemshak, N36°01', E51°28', 2890 m, 5.x.2017, *Hippophae rhamnoides*, M. Lashkari leg. (KGUT), KGUT: 1 ♂, 1 ♀ slide mounted, many ♂♂, ♀♀ preserved in 70% ethanol.

Description. Good descriptions are available in Lashkari *et al.* (2022).

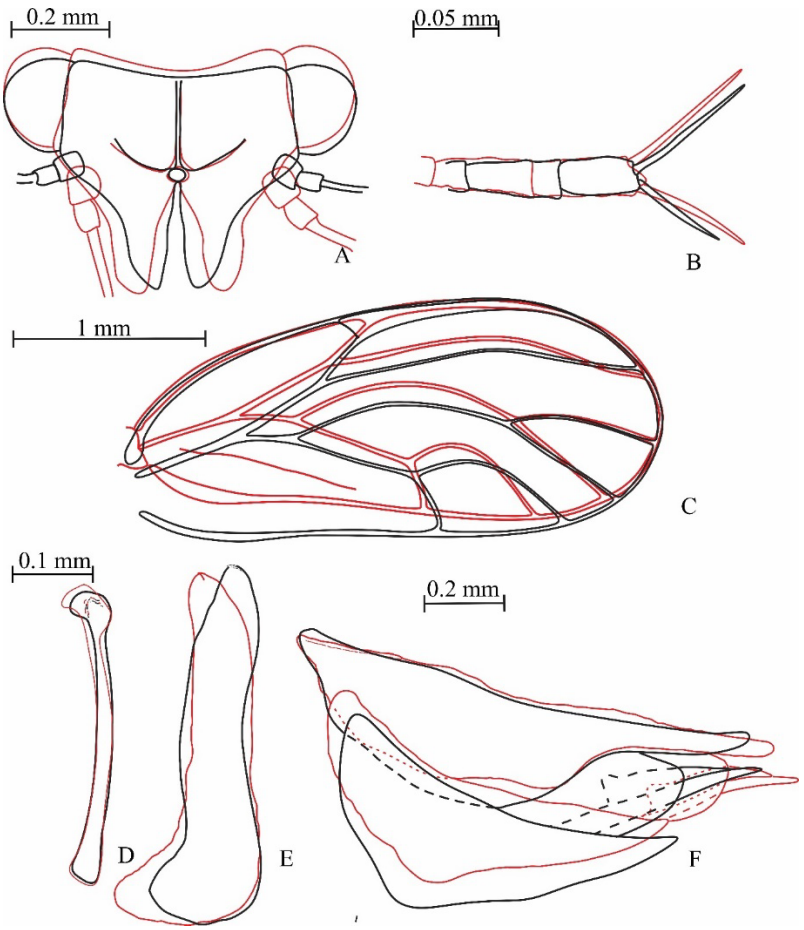

Fig. 3: Superimposed forewing shapes of two Sea-buckthorn psyllids species: *C. nasuta* (Red line), *C. zetterstedti* (Black line). A, Head, Frontal view; B, Antennal segments IX and X and terminal setae; C, forewing; D, Distal segment of aedeagus, lateral view; E, Paramere, lateral view; F, Female terminalia, lateral view.

Table 2. Morphological differences and distribution ranges of *Cacopsylla zetterstedti* (Thomson, 1877) and *C. nasuta* (Horváth, 1904).

	Structure	*C. zetterstedti*	*C. nasuta*
1	Body colour	Brown and dark brown	Yellow-green
2	Genal processes	Wider at base, not longer than vertex (Figs 1C, 3A)	Narrower at base, slightly longer than vertex (Fig. 3A)
3	Antenna length	1.7–1.9 mm	1.3–1.4 mm
4	Relative length of antennal segment 10 and terminal setae	1.0 : 1.0 : 1.6 (Figs 1D, 3B)	1.0 : 1.0 : 1.4 (Fig. 3B)
5	Forewing length/ width ratio	2.1–2.2	2.4–2.5
6	Wing shape	Broader (Figs 1E, 3C)	Elongated (Fig. 3C)
7	Basal half of the wing	Wider (Fig. 3C)	Narrower (Fig. 3C)
8	Cell c+sc	Broader (Fig. 3C)	Narrower (Fig. 3C)
9	Cell r_1	Broader (Fig. 3C)	Narrower (Fig. 3C)
10	Vein Rs	Curved (Fig. 3C)	Strongly curved (Fig. 3C)
11	Vein M	Curved (Fig. 3C)	Strongly curved (Fig. 3C)
12	Surface spinules in cells r1, r2, m1, and m2	Not constricted apically (Fig. 1E)	Apically constricted (showed in Lashkari *et al.*, 2022)
13	Apical inflation of distal segment of aedeagus	Relatively rounded and smaller, about a sixth of total segmental length (Figs 1F, 3D)	Relatively massive and bigger, about a fifth of total segmental length (Fig. 3D)
14	Paramere, in profile	Weakly curved, evenly tapering in apical third (Fig. 3E)	Almost straight, with subparallel fore and hind margins in apical third (Lashkari *et al.*, 2022)
15	Dorsal outline of female proctiger	Weakly wavy (Figs 1G, 3F)	Almost straight (Fig. 3F)
16	Apex of female proctiger, in profile	Slightly thickened (Figs 1G, 3F)	Not thickened (Fig. 3F)
17	Dorsal and ventral valvulae, in profile	Very slightly curved (Figs 1G, 3F)	Uniformly curved upwards (Fig. 3F)
18	Distribution	Palearctic: From Europe to Central Asia	Mountain ranges of Iran, Central Asia, Siberia, and possibly the Caucasus (Lashkari *et al.*, 2022)

Geometric morphometrics (GM) analysis

In the GM analysis, superimposed landmarks on the forewings of the two *Cacopsylla* species revealed considerable variation, particularly in the marginal landmarks 1–10 (Fig. 2E). One-way MANOVA indicated a significant difference in mean wing shape between the studied species (Wilks' lambda=0.0660, $p < 0.0001$). The plot of the partial warp score matrix is presented in Fig. 2B. Superimposed forewings showed that the forewings of *C. zetterstedti* are broader with a wider basal half; also, cell c+sc and cell r_1 are broader than in *C. nasuta*. In contrast, veins Rs and M are more curved in *C. nasuta* (Figs 2C –E).

Key to the *Cacopsylla* spp. feeding on *Hippophae rhamnoides* in Iran

A detailed summary of the diagnostic differences between *C. zetterstedti* and *C. nasuta* is provided in Table 2 and Figures 1-3.

Discussion

Based on the literature, a total of 44 psyllid species have been recorded in association with *H. rhamnoides* worldwide. The 44 species belong to the Psyllidae, Psyllinae (*Cacopsylla* 25 spp., *Psylla* 5 spp.) and Triozidae (*Bactericera* 3 spp., *Hippophaetrioza* 9 spp., *Trioza* 1 sp., *Trisetitrioza* 1 sp.) (Table 1). The newly reported species is morphologically similar to but distinct from, *C. nasuta*. According to Šulc (1913), *C. nasuta* and *C. zetterstedti* (as *Psylla phaeoptera*) can be distinguished by the shape of the dorsal and ventral valvulae of the female ovipositor, antennal length and the presence or absence of surface spinules in the apical half of the forewing. Here, we provide additional details, particularly on the forewing characters, based on GM analysis. GM analysis is a powerful tool to study shape and has been known to detect similarities and differences among homologous morphological structures. In Psylloidea, GM studies have been used to distinguish different populations within the same species (Lashkari *et al.*, 2013; Lashkari and Iranmanesh, 2015; Mostafavi *et al.*, 2018), to identify closely related species (Shamsi Gushki *et al.*, 2018; Serbina & Mennecart, 2018; Lashkari *et al.*, 2020; Lashkari *et al.*, 2021) and to investigate evolutionary relationships (Serbina & Mennecart, 2018).

Cacopsylla zetterstedti was originally described from Norway (Thomson, 1877) and is now widely distributed across the Palearctic, spanning northern, western, central, and parts of Central Asia. Its distribution

ranges from Scandinavia (Norway: Thomson, 1877; Sweden: Ossiannilsson, 1992; Denmark: Ossiannilsson, 1992) to western and central Europe (Austria: Löw, 1879, as *Psylla phaeoptera*; Germany: Ossiannilsson, 1992; France: Ouvrard *et al.*, 2015; Italy: Conci & Tamanini, 1984; Switzerland: Löw, 1879; Schaefer, 1949, as *Psylla phaeoptera*; Great Britain: Hodkinson & White, 1979; the Netherlands: Lauterer & Malenovský, 2002; Czechoslovakia: Lauterer, 1982; Poland: Ossiannilsson, 1992), the Caucasus (Georgia: Loginova, 1968), the Middle East (Turkey: Burckhardt & Önuçar, 1993; Iran: present study), and Central Asia (Tajikistan, Uzbekistan, Kyrgyzstan: Baeva, 1985; Altai region of Russia: Labina, 2008). This broad distribution highlights the species' adaptation to temperate climates and its close association with its monophagous host, *H. rhamnoides*. From a biogeographical perspective, the species' range can be divided into two main clusters: 1- Western Palearctic cluster: includes western and central Europe and Scandinavia (Austria, Germany, France, Italy, Switzerland, Great Britain, the Netherlands, Czechoslovakia, Poland, Denmark, Norway, Sweden), 2- Eastern Palearctic–Central Asian cluster: includes the Caucasus (Georgia), the Middle East (Turkey, Iran), and Central Asia (Tajikistan, Uzbekistan, Kyrgyzstan, Altai region of Russia). The record of *C. zetterstedti* from Iran represents the south-westernmost limit of its Asian distribution and significantly extends its known range. The observed two-cluster distribution pattern (Western Palearctic and Eastern Palearctic–Central Asian) provides insight into potential dispersal routes across Eurasia, likely shaped by the distribution of its monophagous host, *H. rhamnoides*, and temperate climatic conditions. These findings offer a framework for exploring the relationships between geographic distribution, host specificity, and ecological adaptation in this species.

Author's Contributions

The author confirms sole responsibility for the following: conceptualization, methodology, formal analysis, investigation, draft preparation, final review and edit, visualization, supervision, project administration and funding acquisition.

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Data Availability Statement

The examined specimens are deposited in the Department of Biodiversity, Institute of Science and High Technology and Environmental Sciences, Graduate University of Advanced Technology, Kerman, Iran.

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Ethics Approval and Consent to Participate

Insects were used in this study. All applicable international, national, and institutional guidelines for the care and use of animals were followed. This article does not contain any studies with human participants performed by any of the authors.

Consent for Publication

Not applicable

Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this paper.

Generative AI statement

The author declares that no Gen AI was used in the creation of this manuscript.

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Research Article

پسیل‌های (Hem., Psylloidea) مرتبط با درخت سنجد تلخ (*Hippophae rhamnoides*): فهرست جامع گونه‌ها و گزارش رکورد جدید از ایران

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چکیده: در حال حاضر در سراسر جهان، در مجموع ۴۴ گونه پسیل مرتبط با سنجد تلخ، *Hippophae rhamnoides* ، شناخته شده است. با وجود این تنوع جهانی، تا کنون تنها یک گونه، *Cacopsylla nasuta* (Förster, 1848)، از ایران گزارش شده است. در این مطالعه یک گونه دیگر، *Cacopsylla zetterstedti* (Thomson, 1877)، برای نخستین بار از ایران گزارش می‌شود. همچنین فهرست جامعی از تمام گونه‌های پسیل مرتبط با *H. rhamnoides* در دنیا ارائه و کلید شناسایی گونه‌های موجود در ایران ارائه شده است. همچنین تحلیل ریخت‌سنجی هندسی بال جلویی برای بررسی تفاوت‌های تشخیصی میان دو گونه‌ی مورد مطالعه به کار گرفته شده است. این گزارش جدید، دامنه‌ی پراکنش شناخته‌شده‌ی *C. zetterstedti* در آسیا را به طور قابل توجهی گسترش می‌دهد.

کلمات کلیدی: *Cacopsylla*، Psyllidae، Triozidae، مورفومتریک هندسی، ایران.

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