

Research Article

Contribution to the genus *Dusona* Cameron, 1901 (Hymenoptera, Ichneumonidae, Campopleginae) from Iran, with three new records and an updated checklist

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Abstract: The species of the genus *Dusona* Cameron, 1901 (Hymenoptera: Ichneumonidae: Campopleginae) are studied in four provinces of Iran (Mazandaran, Guilan, Alborz and Fars). Specimens were collected using Malaise traps during 2010–2012. Eight species of *Dusona* were collected and identified, among them three species, *D. libertatis* (Teunissen, 1947), *D. limnobia* (Thomson, 1887), and *D. disclosa* (Förster, 1868) represent new records for the fauna of Iran. Morphological characteristics of the newly recorded species are illustrated. Additionally, an updated checklist of *Dusona* species known from Iran is provided, along with zoogeographical distribution maps for all species collected in this study.

Keywords: Taxonomy, Parasitoid, Distribution, New records

Introduction

The subfamily Campopleginae Foerster, 1869 (Hymenoptera, Ichneumonidae) includes more than 2500 valid described species worldwide (Haraldseide, 2021; Riedel, 2017, 2018; Riedel *et al.*, 2019a, 2019b; Shaw *et al.*, 2016; Tigner, 2017; Vas, 2019a, 2019b, 2019c, 2020, 2022, 2023; Vas *et al.*, 2022). In a recent publication by Karimi *et al.* (2023), they documented 95 species of the subfamily Campopleginae from Iran. However, a comprehensive literature review indicates that the number of identified species within this subfamily in Iran is actually 165 (Talebi *et al.*, 2005; Karimpour *et al.*, 2005; Fathi *et al.*, 2012; Barahoei *et al.*, 2012, 2013; Yu *et al.*, 2016; Mohebban *et al.*, 2016; Shaw *et al.*, 2016;

Amiri *et al.*, 2017; Mohammadi-Khoramabadi *et al.*, 2017, 2018; Mohammadi-Khoramabadi and Ziaaddini, 2017; Riedel *et al.*, 2019a, 2019b; Navaeian *et al.*, 2021; Jussila *et al.*, 2021; Samin *et al.*, 2018, 2020, 2021; Sakenin *et al.*, 2020, 2021, 2022; Ghahari *et al.*, 2022; Gadallah *et al.*, 2023; Mohammadi-Khoramabadi, 2023). Moreover, they placed the genus *Hellwigia* and related species, *H. elegans* (Gravenhorst, 1823) in the subfamily Campopleginae, whereas, based on the molecular and morphological analyses, this genus has been transferred to the subfamily Ophioninae (Quicke *et al.* 2005; Rousse *et al.*, 2016; Shaw and Voogd, 2019).

Dusona Cameron, 1901 is the largest genus within Campopleginae, with approximately 442 described species worldwide, of which 125

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species occur in the West Palaearctic region (Yu *et al.*, 2016; Riedel *et al.*, 2019b; Mohammadi-Khoramabadi and Riedel, 2020; Meier *et al.*, 2022). The species of *Dusona* can be easily recognized by the combination of the following characters: inner margin of compound eyes notched opposite antennal socket, propodeal spiracle elongate, compressed metasoma, large and usually rhombic, pointed or stalked areolet, elongated petiolus, with suture obliterated or anteriorly positioned far lower than the middle, almost ventral. *Dusona* are primarily parasitoids of various Lepidoptera families, including Drepanidae, Erebidae, Geometridae, Noctuidae, Nolidae, and Notodontidae, with one exception: *D. minor* (Provancher, 1879) has been documented as a parasitoid of the Juniper Sawfly, *Monoctenus juniperi* (Linnaeus, 1758) (Hym.: Diprionidae) (Horstmann, 2011).

Before this study, 25 species of the genus *Dusona* were reported from Iran (Hinz and Horstmann, 2004; Horstmann, 2009; Riedel, 2019; Sakenin *et al.*, 2020, 2021, 2022; Jussila *et al.*, 2021; Gadallah *et al.*, 2023; Samin *et al.*, 2018, 2020, 2021; Ghahari *et al.*, 2022; Mohammadi-Khoramabadi and Riedel, 2020; Mohammadi-Khoramabadi *et al.*, 2020; Karimi, *et al.*, 2023). This paper contributes to knowledge of the genus *Dusona* in Iran by providing new records of three species for the country.

Materials and Methods

Sampling was conducted in Mazandaran, Guilan, Alborz, and Fars provinces of Iran from April 2010 to August 2012 using Malaise traps. The material was extracted from the collecting jars of traps weekly in Alborz, Fars, and Guilan provinces and every two weeks in Mazandaran province, then transferred to the laboratory at Tarbiat Modares University. To prepare the specimens for study, the AXA procedure was employed: specimens were treated with a mixture of ethanol 60% and Xylene 40% for 18 hours, followed by immersion in amyl acetate for 12 hours (AXA). Subsequently, the specimens were placed on filter paper for drying (Achterberg, 2009). The dried specimens were then card mounted, labeled, and identified using an

OlympusTM stereomicroscope model SZX9. The specimens were identified using the identification keys for Western Palearctic *Dusona* species provided by Horstmann (2009) and Meier *et al.* (2022). Photos were taken with a DS126211 Canon Camera, and the images were edited using Adobe Photoshop CS5 portable 2018 software. Morphological terminology follows Townes (1969) and Hinz and Horstmann (2004). Distribution maps for *Dusona* species was prepared using the online SimpleMappr software (Shorthouse, 2010). All specimens are deposited in the Tarbiat Modares University Collection (TMUC).

The following abbreviations are used: OD – maximum diameter of a posterior ocellus; OOL – minimum distance between posterior ocellus and eye margin; POL – minimum distance between the posterior ocelli; GI (Genal Index) – ratio of the distance between the junction of genal and the hypostomal carinae and the base of the mandible to the basal width of the mandible.

Results

We examined 72 specimens representing eight species of the genus *Dusona*. Three species are newly recorded from Iran marked with two asterisks (**).

Family Ichneumonidae Latreille, 1802

Subfamily Campopleginae Förster, 1869

Genus *Dusona* Cameron, 1901

Dusona Cameron, 1901: 107. Type species: *Dusona stramineipes* Cameron, 1901

Dusona bicoloripes (Ashmead, 1906)

Material examined: IRAN, Guilan province, Rudsar County, Ziaz (36°52'30"N, 50°13'24"E, 490 m a.s.l) 19–26.iv.2010 (1♀), 04–12.iv.2010 (1♀); Mazandaran province, Noor, Chamestan, Tangehvaz (36°21'55.68" N, 52°06'10.32" E, 702 m a. s. l.), 22.vi–07.v.2011 (2♀), leg: Mohammad Khayrandish; Fars province, Eghlid County, Dejkorad (30°43'59.16" N, 51°57'03.07" E, 2168 m a. s. l), 11–25.viii.2012 (1♀), leg: Abbas Amiri.

Distribution in Iran: Golestan Province (Sakenin *et al.*, 2020); Guilan, Mazandaran and Fars provinces (current study).

General distribution: Palaearctic (Yu *et al.*, 2016).

***Dusona disclusa* (Förster, 1868)** (Figs. 1A–F)**

Material examined: IRAN, Alborz province, Chalous Road, Shahrestanak (35°57'34.98" N, 51°22'20.34" E, 2305 m a.

s. l.), 24–31.viii.2010 (1♂), leg: Ahmad Nadimi.

Distribution in Iran: Alborz province (current study).

General distribution: Western Palaearctic (Yu *et al.*, 2016), and Iran (new record).

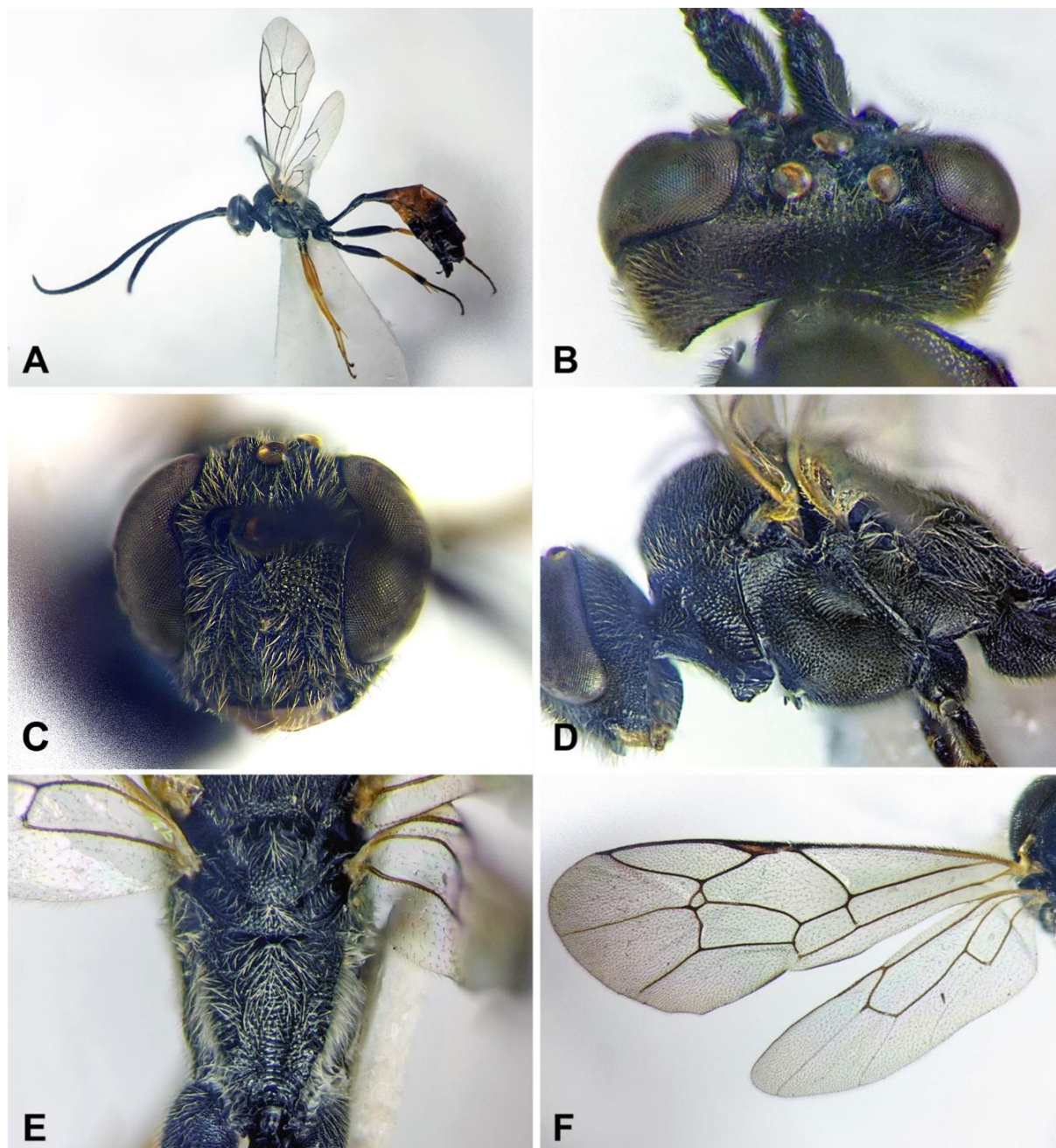


Figure 1 *Dusona disclusa* (Förster, 1868), male, **A)** habitus, lateral view; **B)** Head, dorsal view; **C)** Head, frontal view; **D)** Mesosoma, lateral view; **E)** Propodeum, dorsal view; **F)** Wings venation.

Morphological characteristics

Male: Body length 8.7 mm (Fig. 1A); antenna with 36 flagellomeres; face punctate, its width $1.6 \times$ as long as its height (Fig. 1C); mandible yellow, basally darkened; malar space $0.6 \times$ as long as basal width of mandible; antennal carina not raised, narrow; POL $1.3 \times$ as long as OD; OOL $0.8 \times$ as long as OD (Fig. 1B); genal carina joining hypostomal carina at a nearly right angle, at base of mandible; mesopleuron punctate on a granular background, speculum granulate, striate in front (Fig. 1D); epicnemial carina raised ventrally, rather deeply emarginated medially; ventral part of epicnemial carina joining with transverse carina, lower section of pleural part of epicnemial carina present; propodeum with a rather deep longitudinal furrow with transverse carina (Fig. 1E); areolet petiolate (Fig. 1F); front femur orange, hind femur black, hind tibia yellow, with basal black spot and apical black ring, ring extending 0.2 as long as hind tibia; petiolus without glymmae; epipleurum fused with 3rd tergite, metasoma red medially (apical 0.4 of 2nd, all of 3rd and basal 0.8 of 4th tergites), black basally and apically.

***Dusona erythrogaster* (Förster, 1868)**

Material examined: IRAN, Guilan province, Rudsar County, Rahimabad District, Orkom ($36^{\circ}45'44.34''$ N, $50^{\circ}18'11.88''$ E, 1201 m a.s.l.), 07–14.vi.2010 (1♀), Qazi Chak ($36^{\circ}45'52.62''$ N, $50^{\circ}20'01.08''$ E, 1787 m a.s.l.), 07–14.vi.2010 (1♂, 3♀), 24–31.vi.2010 (1♀); Mazandaran province, Noor ($36^{\circ}34'52.98''$ N, $52^{\circ}02'45.78''$ E, -14 m b.s.l.), 07.v.–22.vi.2011 (1♀), 27.v.–07.vi.2011 (3♀, 1♂), leg.: Mohammad Khayrandish.

Distribution in Iran: Mazandaran (Mohammadi-Khoramabadi and Riedel, 2020) and Guilan provinces (current study).

General distribution: Palaearctic (Yu *et al.* 2016).

***Dusona libertatis* (Teunissen, 1947)* (Figs. 2A–F)**

Material examined: IRAN, Guilan province, Rudsar County, Ziaz ($36^{\circ}52'30''$ N, $50^{\circ}13'24''$ E, 490 m a.s.l.), 27.ix–04.x.2010 (1♀); Mazandaran province, Noor, Chamestan, Tangehvaz ($36^{\circ}21'55.68''$ N, $52^{\circ}06'10.32''$ E, 702 m a. s. l.),

27.v–07.vi.2011 (1♀), ($36^{\circ}18'51.42''$ N, $52^{\circ}07'48.00''$ E, 1353 m a. s. l.), 14–29.viii.2011 (2♀), leg: Mohammad Khayrandish.

Distribution in Iran: Guilan and Mazandaran provinces (current study).

General distribution: Western Palaearctic (Yu *et al.*, 2016), and Iran (new record).

Morphological characteristics

Female: Body length 14 mm (Fig. 2A); antenna with 59 antennomeres; face punctate, its width $1.4 \times$ as long as its height (Fig. 2C); malar space $0.4 \times$ as long as basal width of mandible, mandibles brownish yellow with black base; antennal carina not raised, narrow; POL $1.2 \times$ as long as OD; OOL $0.8 \times$ as long as OD (Fig. 2B); genal carina raised ventrally and medially; mesopleuron punctate on a leathery background, speculum striate (Fig. 2D); epicnemial carina not raised ventrally, with no emargination medially; ventral part of epicnemial carina joining with pleural part; costula present, apical half of median longitude carina is discernable; area petiolaris with a wide through, transversely coarsely wrinkled (Fig. 2E); areolet large and petiolate (Fig. 2F); hind tibia light yellow; petiolus with glymmae; epipleurum separated from 3rd tergite by a crease, median gastral tergites yellow.

***Dusona limnobia* (Thomson, 1887) * (Figs. 3A–F)**

Material examined: IRAN, Alborz province, Karaj County, Sarzarat ($35^{\circ}55'10.38''$ N, $51^{\circ}06'51.24''$ E, 1980 m a.s.l.), 09–17.v.2010 (1♂), 17–24.v.2010 (1♀), 25.v–01.vi.2010 (2♀, 3♂), 28.vi–06.vii.2010 (1♀, 2♂), 06–14.vii.2010 (1♂), 20–28.vii.2010 (2♂), 28.vii–03.viii.2010 (1♀), 03–10.viii.2010 (1♂); Chalous Road, Arangeh ($35^{\circ}55'07.20''$ N, $51^{\circ}05'09.24''$ E, 1891 m a. s. l.), 22–29.vi.2010 (4♂), 29.vi–06.vii.2010 (6♂), 06–13.vii.2010 (7♂), 13–20.vii.2010 (2♂), 20–28.vii.2010 (1♂); Shahrestanak ($35^{\circ}57'34.98''$ N, $51^{\circ}22'20.34''$ E, 2305 m a. s. l.), 29.vi–06.vii.2010 (1♀), leg: Ahmad Nadimi; Guilan province, Rudsar, Rahim abad, Ziaz ($36^{\circ}52'27.18''$ N, $50^{\circ}13'24.78''$ E, 490 m a. s. l.), 21–28.vi.2010 (1♂), 27.ix–04.x.2010 (1♂), 28.vi–05.vii.2010 (1♂), leg: Mohammad

Khayrandish; Fars province, Eghlid County, Shahremian (30°54'39.07" N 52°28'16.82" E, 2120 m a. s. l), 04–18.vi.2012 (1♀, 1♂), leg: Abbas Amiri.

Distribution in Iran: Alborz, Guilan and Fars provinces (current study).

General distribution: Palaearctic (Yu *et al.*, 2016), Iran (new record).

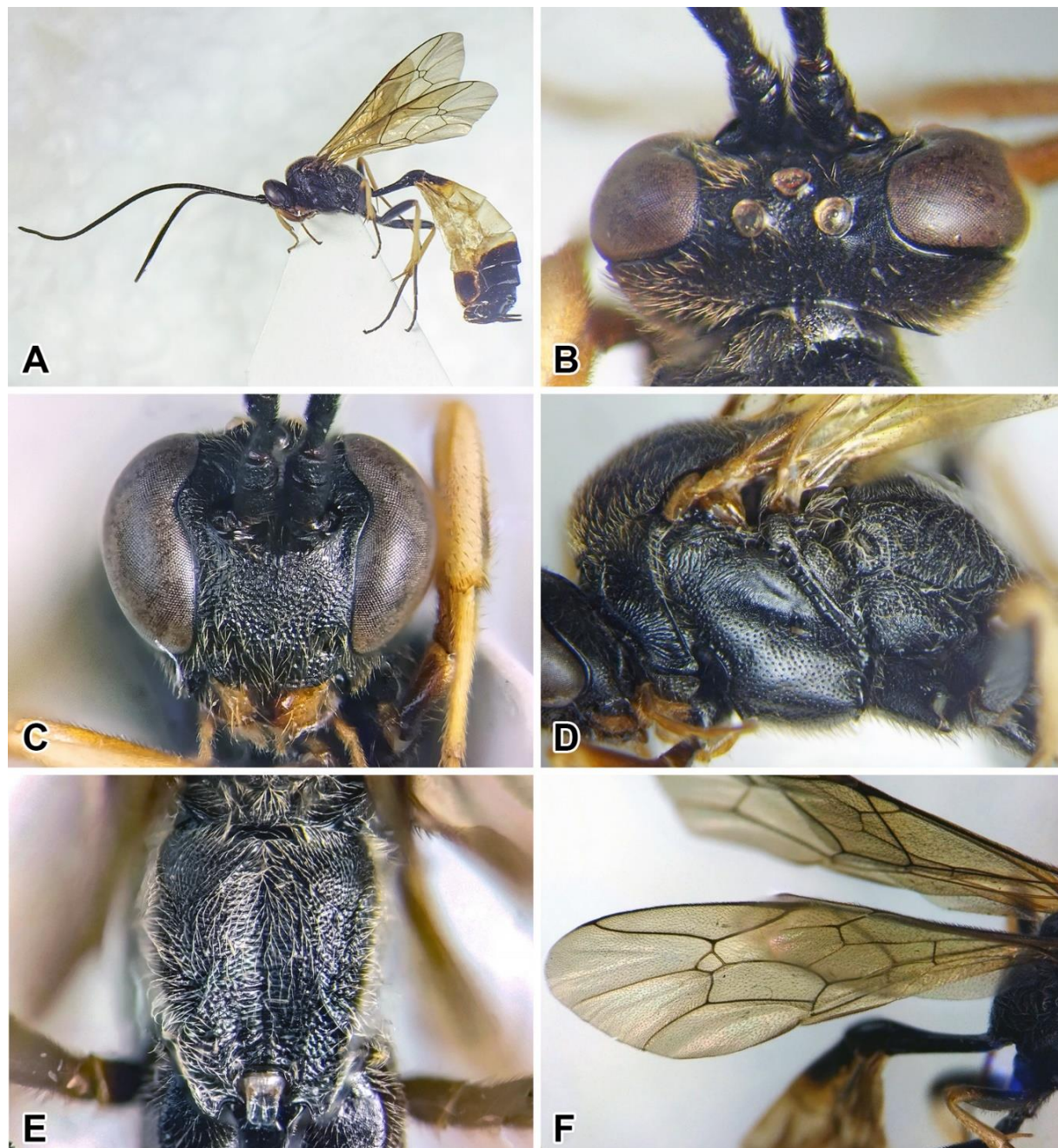


Figure 2 *Dusona libertatis* (Teunissen, 1947), female, **A)** habitus, lateral view; **B)** Head, dorsal view; **C)** Head, frontal view; **D)** Mesosoma, lateral view; **E)** Propodeum; **F)** Front wing.

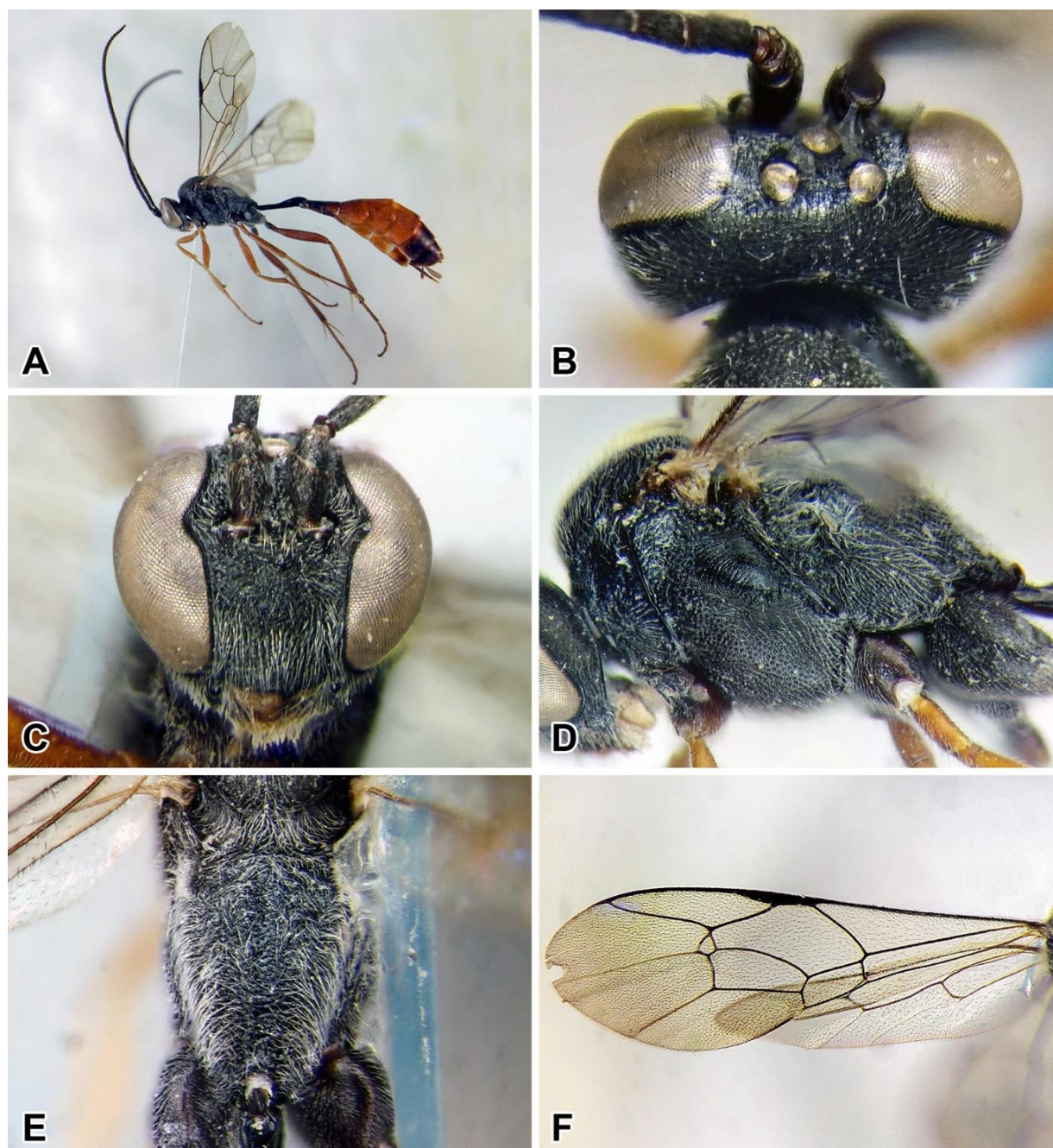


Figure 3 *Dusona limnobia* (Thomson, 1887), female. **A)** Habitus; **B)** Head, dorsal view; **C)** Head, frontal view; **D)** Mesosoma, lateral view; **E)** Propodeum, dorsal view; **F)** Front wing.

Morphological characteristics

Female: Body length 8.5-9.8 mm (Fig. 3A); antenna with 41 antennomeres; face punctate, its width $1 \times$ as long as its height (Fig. 3C); antennal carina not raised, narrow; malar space $0.3 \times$ as long as basal width of mandible,

mandible brownish yellow; POL $1.2 \times$ as long as OD; OOL $0.6 \times$ as long as OD (Fig. 3B); genal carina joining hypostomal carina at a right angle, near to base of mandible, genal index 0.2; mesopleuron punctate on a granular background, speculum striate in front (Fig.

3D); epicnemial carina slightly raised ventrally, with no emargination medially; ventral part of epicnemial carina joining with transvers part; anterior transvers carina on propodeum distinct, petiolar area with weak transvers carina (Fig. 3E); epicnemial carina not raised ventrally; areolet petiolate (Fig. 3F); hind femur red, hind tibia blackish brown; epipleurum fused with 3rd tergite, metasoma red medially (3rd, 4th and 5th tergites), black basally and apically.

***Dusona subimpres* (Förster, 1868)**

Material examined: IRAN, Guilan province, Astaneh Ashrafiyeh, Eshman kamachal (37°22'03.66" N, 49°57'57.84" E, -1 m b. s. l.), 16–24.v.2010 (1♂), 26.vii–02.viii.2010 (1♂), 13–20.ix.2010 (1♀, 2♂), 20–28.ix.2010 (2♂), leg: Ahmad Nadimi; Fars province, Eghlid County, Shahrman Village (30°54'39.07" N, 52°28'16.82" E, 2120 m a. s. l.), 22.iv–06.v.2012 (1♀), leg: Abbas Amiri.

Distribution in Iran: East Azarbaijan (Sakenin *et al.*, 2022), Guilan and Fars provinces (current study).

General distribution: Palaearctic (Yu *et al.* 2016).

Dusona terebrator* (Förster, 1868)

Material examined: IRAN, Alborz province, Karaj County, Sarziarat (35°55'10.38" N, 51°06'51.24" E, 1980 m a.s.l.), 01–08.vi.2010 (1♀), leg: Ahmad Nadimi.

Distribution in Iran: Golestan (Samin *et al.*, 2018) and Alborz provinces (current study).

General distribution: Palaearctic (Yu *et al.*, 2016).

***Dusona tenuis* (Förster, 1868)**

Material examined: IRAN, Guilan province, Rudsar, Rahim abad, Ziaz (36°52'27.18" N, 50°13'24.78" E, 490 m a. s. l.), 2–9.viii.2010 (1♀), leg: Ahmad Nadimi.

Distribution in Iran: Markazi (Jussila *et al.*, 2021) and Guilan provinces (Current study).

General distribution: Palaearctic and Oriental (Yu *et al.*, 2016).

Discussion

In this study, three species of *Dusona* are recorded for the first time from Iran: *D. libertatis*, *D. limnobia* and *D. disclusa*, as well as five species with new provincial records from the country. Recently, Karimi *et al.* (2023) reported seven Iranian species of the genus *Dusona* in their article, whereas we present a total of 28 species of this genus for Iran, including our results (Table 1). Among the 31 provinces of Iran, *Dusona* have been recorded from 13 provinces (Alborz, Ardabil, East Azarbaijan, Fars, Golestan, Guilan, Kerman, Markazi, Mazandaran, Northern Khorasan, Qazvin, Southern Khorasan, West Azarbaijan), in which Guilan with eight species was found to be the richest, followed by both Ardabil and East Azarbaijan provinces with three species. Notably, 18 out of these 28 species (64%) are recorded from provinces located in Alborz mountain range, indicating the great biodiversity in this region. Furthermore, our results show that many parts of the country are still unexplored, and we expect that the species number of the genus *Dusona* in Iran will be significantly increased in the future. Also, parasitoid-host relationships were recorded for 23 Iranian *Dusona* species, indicating that all species are parasitoids of Lepidoptera, particularly the families Geometridae, Lasiocampidae, Lycaenidae, Lymantriidae, Noctuidae, Notodontidae, Nymphalidae and Tortricidae (Yu *et al.*, 2016). It should be noted that no hosts have been reported for any *Dusona* species from Iran to date. The number of Iranian *Dusona* species has now raised to 28, which compares to adjacent countries as follows: 153 species in Russia, 35 species in Turkey, three in Turkmenistan, 16 in Azerbaijan, and none recorded yet from Iraq and Afghanistan (Yu *et al.*, 2016; Belokobylskij and Lelej, 2019; Kaplan and Riedel, 2022). Considering zoogeographical distribution of *Dusona* species collected in this research (Fig. 4), we found that these species distributed in two zoogeographical regions: Palearctic (8 species) and Oriental (1 species) regions, while one species (i.e., *D. tenuis*) is known to occur in both regions.

Table 1 Updated species list of *Dusona* Cameron, 1901 known to occur in Iran. (* new provincial record; ** new record for Iran).

Species	Recorded province	Reference
<i>Dusona annexa</i> (Förster, 1868)	West Azerbaijan	Karimi <i>et al.</i> (2023)
<i>Dusona aversa</i> (Förster, 1868)	Ardabil	Samin <i>et al.</i> (2020)
<i>Dusona bicoloripes</i> (Ashmead, 1906)*	Golestan; Guilan, Fars	Sakenin <i>et al.</i> (2020), Current study
<i>Dusona carinifrons</i> (Holmgren, 1860)	Southern Khorasan	Gadallah <i>et al.</i> (2023)
<i>Dusona circumcinctus</i> (Förster, 1868)	East Azerbaijan	Samin <i>et al.</i> (2021)
<i>Dusona cultrator</i> (Gravenhorst, 1829)	Mazandaran; Northern Khorasan	Mohammadi-Khoramabadi and Riedel (2020), Jussila <i>et al.</i> (2021)
<i>Dusona discusa</i> (Förster, 1868)**	Alborz	Current study
<i>Dusona erythrogaster</i> (Förster, 1868)*	Mazandaran; Guilan	Mohammadi-Khoramabadi and Riedel (2020), Current study
<i>Dusona falcator</i> (Fabricius, 1775)	Ardabil	Samin <i>et al.</i> (2021)
<i>Dusona insignita</i> (Förster, 1868)	Qazvin	Ghahari <i>et al.</i> (2022)
<i>Dusona juvenilis</i> (Förster, 1868)	Golestan	Samin <i>et al.</i> (2020)
<i>Dusona leptogaster</i> (Holmgren, 1860)	Northern Khorasan	Sakenin <i>et al.</i> (2021)
<i>Dusona libertatis</i> (Teunissen, 1947)**	Guilan	Current study
<i>Dusona limnobia</i> (Thomson, 1887)**	Alborz	Current study
<i>Dusona myrtila</i> (Desvignes, 1856)	Guilan	Sakenin <i>et al.</i> (2020)
<i>Dusona nidulator</i> (Fabricius, 1804)	Kerman	Sakenin <i>et al.</i> (2021)
<i>Dusona notabilis</i> (Förster, 1868)	Ardabil	Sakenin <i>et al.</i> (2022)
<i>Dusona opaca</i> (Thomson, 1887)	Qazvin	Ghahari <i>et al.</i> (2022)
<i>Dusona pineticola</i> (Holmgren, 1872)	Guilan	Ghahari <i>et al.</i> (2022)
<i>Dusona rufitergus</i> Riedel and Karimi, 2023	Mazandaran	Riedel <i>et al.</i> (2019b), Krimi <i>et al.</i> (2023)
<i>Dusona rugifer</i> (Förster, 1868)	Golestan	Hinz and horstmann (2004)
<i>Dusona signator</i> (Brauns, 1895)	East Azerbaijan	Sakenin <i>et al.</i> (2022)
<i>Dusona spinipes</i> (Thomson, 1887)	Qazvin	Ghahari <i>et al.</i> (2022)
<i>Dusona stragifex</i> (Förster, 1868)	Guilan	Vas <i>et al.</i> (2023)
<i>Dusona stygia</i> (Förster, 1868)	West Azerbaijan	Hinz and horstmann (2004)
<i>Dusona subimpressa</i> (Förster, 1868)*	East Azerbaijan; Guilan	Sakenin <i>et al.</i> (2022), Current study
<i>Dusona tenuis</i> (Förster, 1868)*	Markazi; Guilan	Jussila <i>et al.</i> (2021), Current study
<i>Dusona terebrator</i> (Förster, 1868)*	Golestan; Alborz	Samin <i>et al.</i> (2018), Current study

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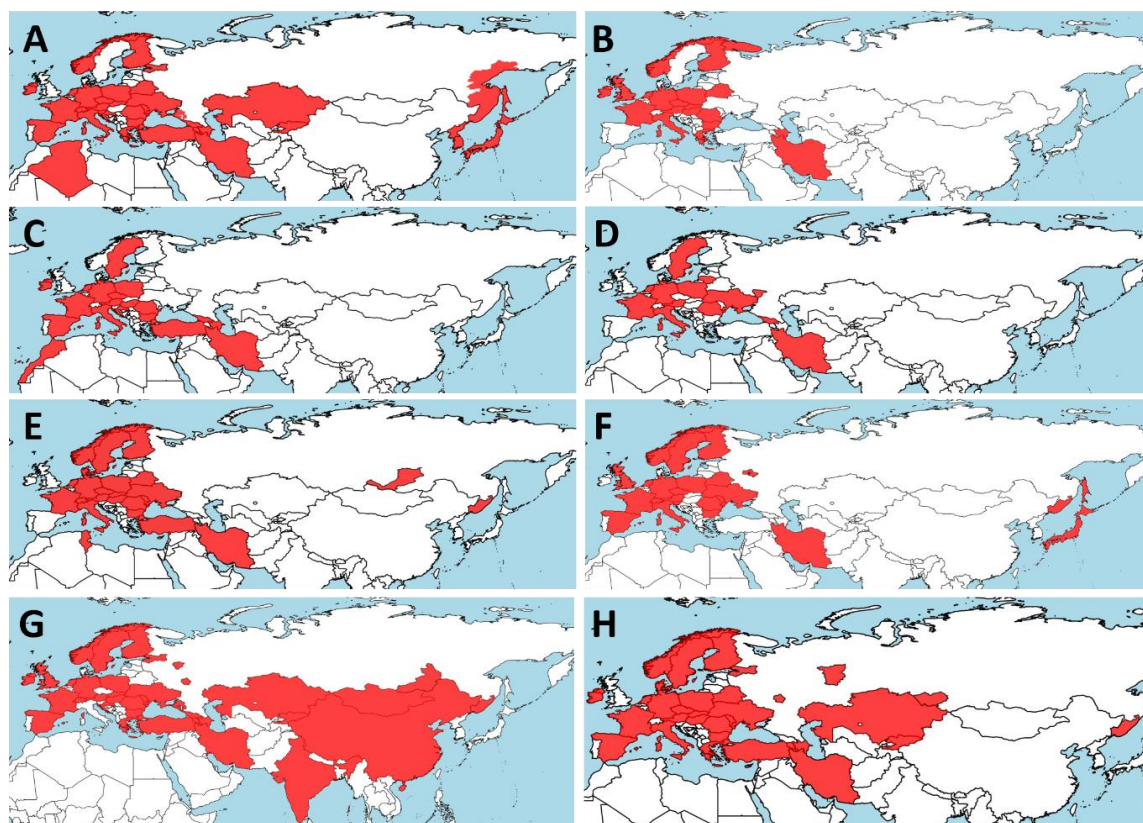


Figure 4 Map of zoogeographical distribution of *Dusa* species collected in this study; A) *D. bicoloripes*; B) *D. disclusa*; C) *D. erythrogaster*; D) *D. libertatis*; E) *D. limnobia*; F) *D. subimpressa*; G) *D. tenuis*; H) *D. terebrator*.

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مطالعه جنس *Dusona* Cameron, 1901 (Hym.: Ichneumonidae, Campopleginae) در ایران، به همراه گزارش جدید سه گونه و چکلیست گونه‌ها

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چکیده: در این پژوهش، جنس *Dusona* Cameron, 1901 (Hymenoptera: Ichneumonidae: Campopleginae) مورد مطالعه قرار گرفت. نمونه‌ها با استفاده از تله‌مالایز طی سال‌های ۱۳۸۹ تا ۱۳۹۱ از چهار استان ایران (مازندران، گیلان، البرز و فارس) جمع‌آوری شدند. هشت گونه از این جنس جمع‌آوری و شناسایی شد که از میان آنها سه گونه *D. disclusa* (Förster, 1868) برای اولین بار از ایران گزارش شدند. ویژگی‌های افتراقی و عکس گونه‌های گزارش شده، چکلیست گونه‌های جنس *Dusona* در ایران و نقشه پراکنش جغرافیایی برای همه گونه‌های جمع‌آوری شده در این مطالعه ارائه شده است.

واژگان کلیدی: طبقه‌بندی، پارازیتوئید، انتشار، گزارش جدید