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Discovery of the genus *Neotrichoporoides* Girault, 1913 (Hymenoptera: Eulophidae) in Iraq, with three new records

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ABSTRACT. Through a survey that was conducted in Basrah Province, Southern Iraq in 2021, specimens were collected from alfalfa fields (*Medicago sativa* L.) using a sweep net. These specimens were identified as *Neotrichoporoides* Girault, 1913 (Hymenoptera: Chalcidoidea, Eulophidae), which is a new report of the genus in Iraq. Three species were collected and identified, i.e. *Neotrichoporoides basiflavus* Li & Li, 2021; *N. cavigena* Graham, 1987; and *N. viridimaculatus* (Fullaway, 1955). An illustrated key for identifying *Neotrichoporoides* species in Iraq and notes on diagnostic characters of the newly recorded species along with illustrations are provided. The distribution map of the Iraqi species is presented. Furthermore, a preliminary checklist of recorded species of Eulophidae from Iraq is provided.

Keywords: Chalcidoidea, checklist, *Medicago sativa*, parasitoid, taxonomy, Tetrastichinae

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INTRODUCTION

The family Eulophidae (Hymenoptera: Chalcidoidea) is the largest in the superfamily with more than 6000 species in 328 genera (UCD Community, 2023). Nevertheless, only a few studies have been done on these important wasps in Iraq (Bouček & Askew, 1968; Al-Azawi, 1967, 1971; OILB, 1971; Swailem et al., 1975; Abdul-Rassoul, 1976; Awadallah et al., 1979a, 1979b; Hassan, 2012; Mansowr et al., 2024). Tetrastichinae Förster, 1856 (Hymenoptera, Eulophidae) is the largest in the family (UCD Community, 2023). The genus *Neotrichoporoides* Girault, 1913 (Hymenoptera: Eulophidae) has 73 species worldwide, and 28 species in the Palaearctic region (UCD Community, 2023; Jafarlu et al., 2023). *Neotrichoporoides* species are primary parasitoids of Diptera (Insecta) in the families Anthomyiidae and Diopsidae (Bouček, 1988; La Salle, 1994). Diagnostic characters of *Neotrichoporoides* are as follows: Body in majority of species with a metallic tint, and occasionally with some parts of the body yellowish; pronotum almost always elongate; mesoscutellum subequal to mesoscutum; funiculars usually elongate; propodeum clearly longer than dorsellum; fore wing with marginal vein 6.5–9.5× as long as stigmal vein; stigma with a short stem (Graham, 1987).

Alfalfa, *Medicago sativa* L. (Fabaceae) is one of the most economically important crops which grows worldwide (Bolton, 1962; Hirsh, 2014). This crop is attacked by many important pests (Miller & Jensen, 1970; Sisterson et al., 2018), and some natural enemies are their parasitoids (Lotfalizadeh et al., 2015; Sisterson et al., 2018; Jafarlu et al., 2022; Mansowr et al., 2024). One of the most important of these parasitoids is the family Eulophidae. Considering these issues, the objectives of this research are (1) to

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report new records of the genus and species for the fauna of Iraq, (2) to present an illustrated identification key for the Iraqi species, and (3) preparation of the first checklist of Eulophidae species in Iraq.

MATERIAL AND METHODS

Sampling was carried out on alfalfa fields from January to December 2021 using sweep net, yellow pan trap, and Malaise trap in different regions of Basrah Province, Southern Iraq (30°30'7.23"N, 47°50'30.93"E) (Fig. 1). The number of yellow pan traps and Malaise traps were 4 and 2 in each station, respectively. Basrah is the largest city and one of the most important regions of Iraq (Fig. 1). This region has a semi-arid climate, and high temperatures (above 50 °C in summers) most of the year (Al-Mayah et al., 2016) and this makes it different from its neighbouring regions in terms of agricultural crops and biodiversity. The collected specimens were placed in containers filled with 70% ethanol. Specimens were examined for detecting the genus *Neotrichoporoides* using an EZ4 binocular stereomicroscope, and identification key provided by Gibson et al. (1997). Morphological terminology followed Gibson et al. (1997) and Yoder et al. (2010). To preserve the specimens, the proposed method of Noyes (1982) was used. Specimens were identified using an Olympus® SZH stereomicroscope and photographed by a Nikon camera installed on an EZ4 binocular stereomicroscope. The photos were edited and inserted in the plates using Adobe Photoshop® CC software (2015.0.0 Release). All materials are deposited in the insect collection of the Hayk Mirzayans Insect Museum (HMIM), Iranian Institute of Plant Protection, Tehran, Iran.

RESULTS

During this study, 106 specimens were collected and identified as *Neotrichoporoides* Girault, 1913 (Hymenoptera: Eulophidae). Examination of the obtained specimens showed they belong to three species, i.e. *Neotrichoporoides basiflavus* Li & Li, 2021; *N. cavigena* Graham, 1987; and *N. viridimaculatus* (Fullaway, 1955). The discovery of the genus *Neotrichoporoides* and all three species are new for the Iraqi fauna.

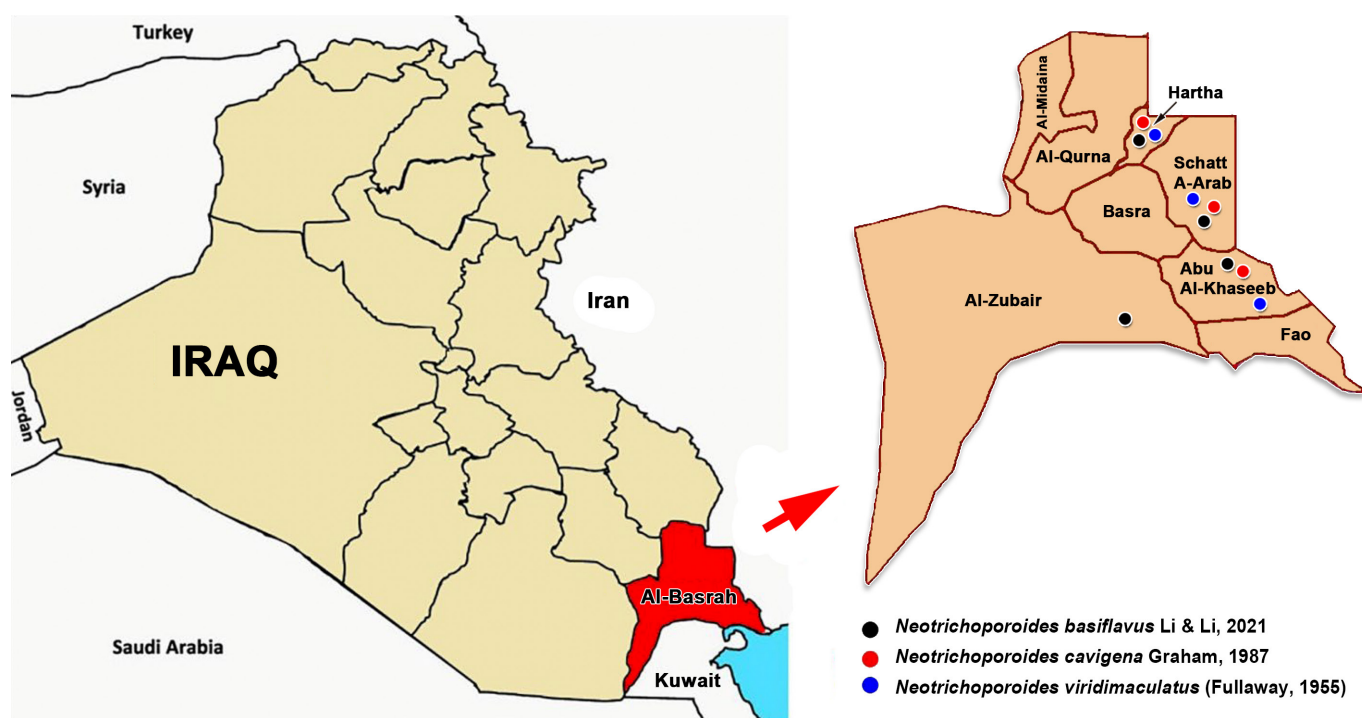


Figure 1. Distribution map of *Neotrichoporoides* Girault, 1913 species in Iraq and Basrah province.

Taxonomic hierarchy

Order Hymenoptera Linnaeus 1758

Superfamily Chalcidoidea Latreille, 1817

Family Eulophidae Westwood, 1829

Subfamily Tetrastichinae Förster, 1856

Genus *Neotrichoporoides* Girault, 1913

[Type species: *Neotrichoporoides uniguttata* Girault, 1913]. *Aprostoceroloides* Girault, 1913; *Tetrastichomorpha* Girault, 1913; *Trichoporoidella* Girault, 1913; *Epiquadrastichus* Girault, 1915; *Paraprostocetus* Girault, 1915; *Burksia* Fullaway, 1955; *Dubiostalon* Szelenyi, 1981; *Neogaleopsomyia* Narendran, 2005.

Neotrichoporoides basiflavus Li & Li, 2021 (Fig. 2)

Material examined. 8 ♂♂ (HMIM), IRAQ - Basrah province, Hartha, 30°36'23"N, 47°42'59"E, 23.iv.2021; swept on alfalfa; Z.F. Mansowr leg; 9 ♂♂ (HMIM), Abo Al-Khaseeb, 30°27'36"N, 47°53'35"E; 05.vii.2021; same data as for preceding; 12 ♂♂ (HMIM), Shatt Al-Arab, 30°32'20"N, 47°50'48"E, 13.x.2021, yellow pan trap, Z.F. Mansowr leg; 4 ♂♂ (HMIM), Zubair, 30°18'43"N, 47°43'37"E; Malaise trap, Z.F. Mansowr leg.

Diagnosis. Male. Body metallic green (Fig. 2) with yellow head except for vertex and occiput (Figs 2A, 2B, 2D); basal gastral tergites and sternites yellow and the rest concolorous with thorax (Figs 2A, 2E2). Antennal scape slightly shorter than eye but reaching vertex; scape slightly more than 4 times, and pedicel about 2 times as long as wide. F1 1.5 times as long as pedicel; toruli situated well above the lower margin of eye. Malar sulcus straight to slightly curved at the end (Figs 2A, 2D). Pronotum with posterior margin concave in the middle (Fig. 2B); mesoscutum 1.8–1.9 times as long as wide; median line absent; metanotum narrow; propodeum with median carina and without paraspiracular carinae; propodeal spiracles rounded and moderate in size (Fig. 2B).

Distribution. Palaearctic: China (Li & Li, 2021), Iraq (new record) (Fig. 1).

Neotrichoporoides cavigena Graham, 1987 (Fig. 3).

Material examined. 8 ♂♂ (HMIM), IRAQ - Basrah province, Hartha, 30°36'23"N, 47°42'59"E, 18.vi.2021, Malaise trap, Z.F. Mansowr leg; 6 ♂♂ (HMIM), Abo Al-Khaseeb, 30°27'36"N, 47°53'35"E, 19.viii.2021, same data as for preceding; 2 ♂♂ (HMIM), Shatt Al-Arab; 30°32'20"N, 47°50'48"E, 28.ix.2021, swept on alfalfa; Z.F. Mansowr leg.

Diagnosis. Male. Body metallic green without any pale marking (Fig. 3) except for yellowish-testaceous legs (Fig. 3A) and dark brown antenna (Figs 3A, 3D). Malar fovea large and deep (Figs 3A, 3D). Antennal scape shorter than eye, and 3 times as long as wide; pedicel 2.2 times as long as wide; F1–F3 2.6 times as long as wide; flagellum almost with the same size as whole body; toruli situated at the middle of face. Malar sulcus distinctly curved (Figs 3A, 3D). Mesoscutum with distinct median line and four adnotaular setae at one row on each side. Propodeum medially 1.6 times as long as dorsellum (Figs 3B).

Distribution. Palaearctic: Bulgaria, China, Czech Republic, France (Graham, 1987), Iraq (new record), Russia (Yegorenkova & Kostjukov, 2006), Slovakia (Kalina, 1989), Turkey (Sakaltas & Gençer, 2005)

Neotrichoporoides viridimaculatus (Fullaway, 1955) (Fig. 4).

[*Burksia*] *Tetrastichus bicolor* Saraswat, 1975; *T. saraswati* Husain & Khan, 1986.

Material examined. 9 ♀♀, 3 ♂♂ (HMIM), IRAQ - Basrah province, Hartha, 30°36'23"N, 47°42'59"E, 18.vi.2021, swept on alfalfa, Z.F. Mansowr leg; 21 ♀♀, 14 ♂♂ (HMIM), Abo Al-Khaseeb, 30°27'36"N, 47°53'35"E, 19.viii.2021, yellow pan trap; Z.F. Mansowr leg; 7 ♀♀, 3 ♂♂ (HMIM), Shatt Al-Arab, 30°32'20"N, 47°50'48"E, 2.xi.2021, Malaise trap, Z.F. Mansowr leg.

Diagnosis. Female. Body mainly yellow (Fig. 4) with metallic green to black markings on mesosoma and metasoma (Figs 4A, 4E, 4F), these are very characteristic and separate this species from other species of the genus. Antenna yellowish-testaceous like the body but slightly darker. Antennal scape slightly (1.1 times) longer than eye. Malar sulcus with small fovea below the eye. F1 2.5 times as long as pedicel (Figs 4A, 4D).

Mesoscutellum with relatively faint submedian grooves, they almost seem absent (Fig. 4E). Propodeum with submedian area metallic green (Fig. 4E, 4F). Gaster in dorsal view with dark spots limited to the lateral parts of tergites, and with a cross-shaped spot just beyond the middle of the gaster to its end (Fig. 4F).

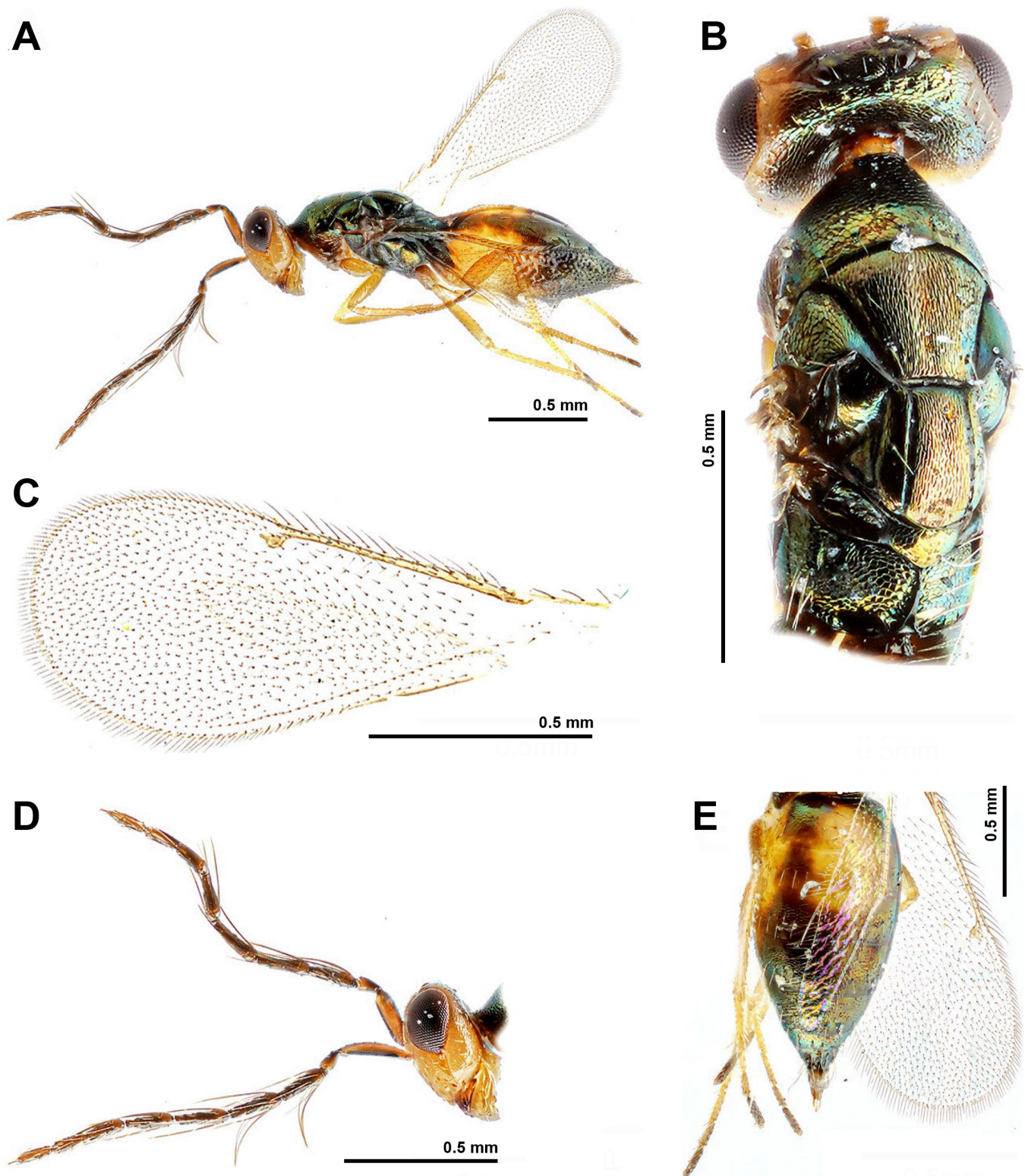


Figure 2. *Neotrichoporoides basiflavus* Li & Li, 2021, male: **A.** General habitus, lateral view; **B.** Head and mesosoma, dorsal view; **C.** Fore wing; **D.** Head and antennae, lateral view; **E.** Gaster, dorsal view.

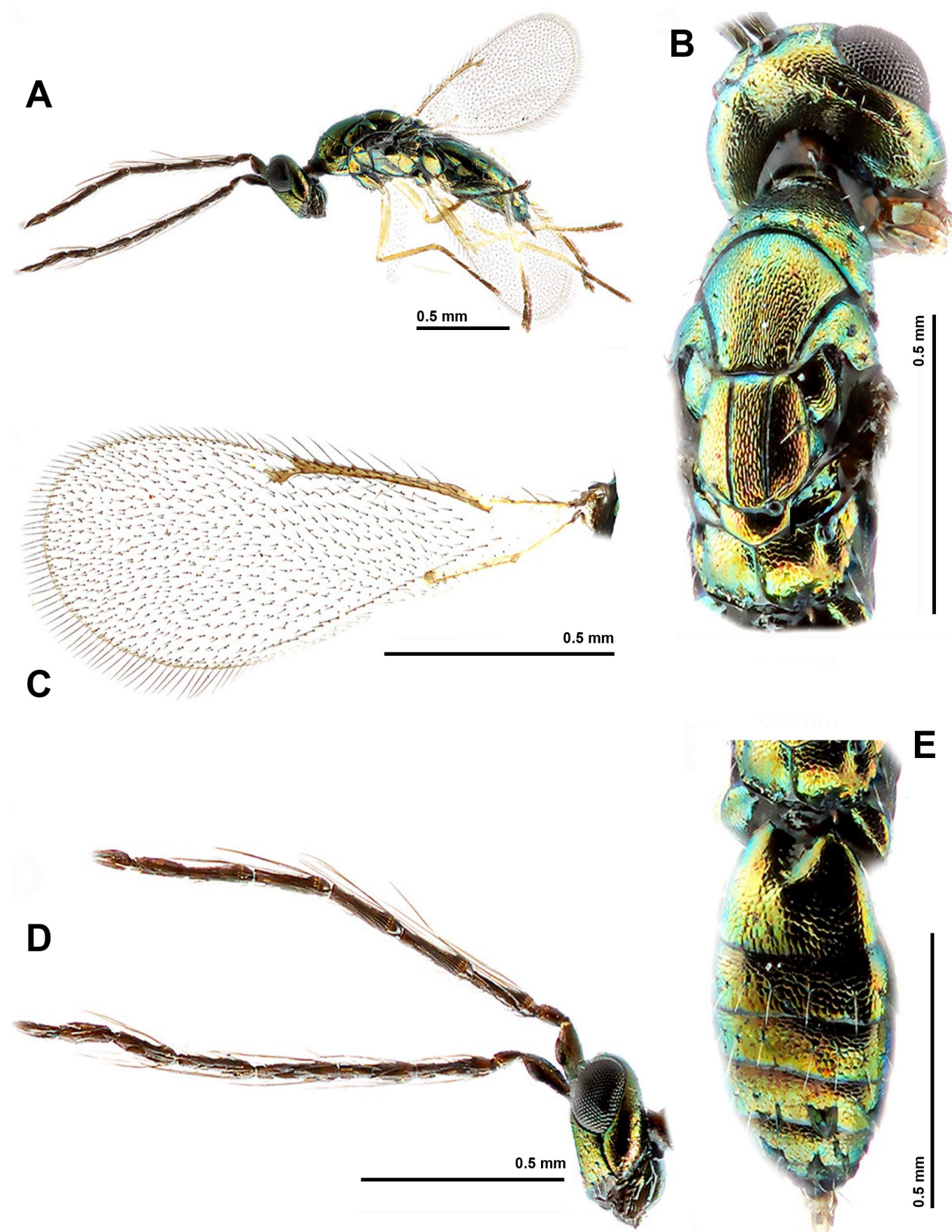


Figure 3. *Neotrichoporoides cavigena* Graham, 1987, male: **A.** General habitus, lateral view; **B.** Head and mesosoma, dorsal view; **C.** Fore wing; **D.** Head and antennae, lateral view; **E.** Propodeum and mesosoma, dorsal view.

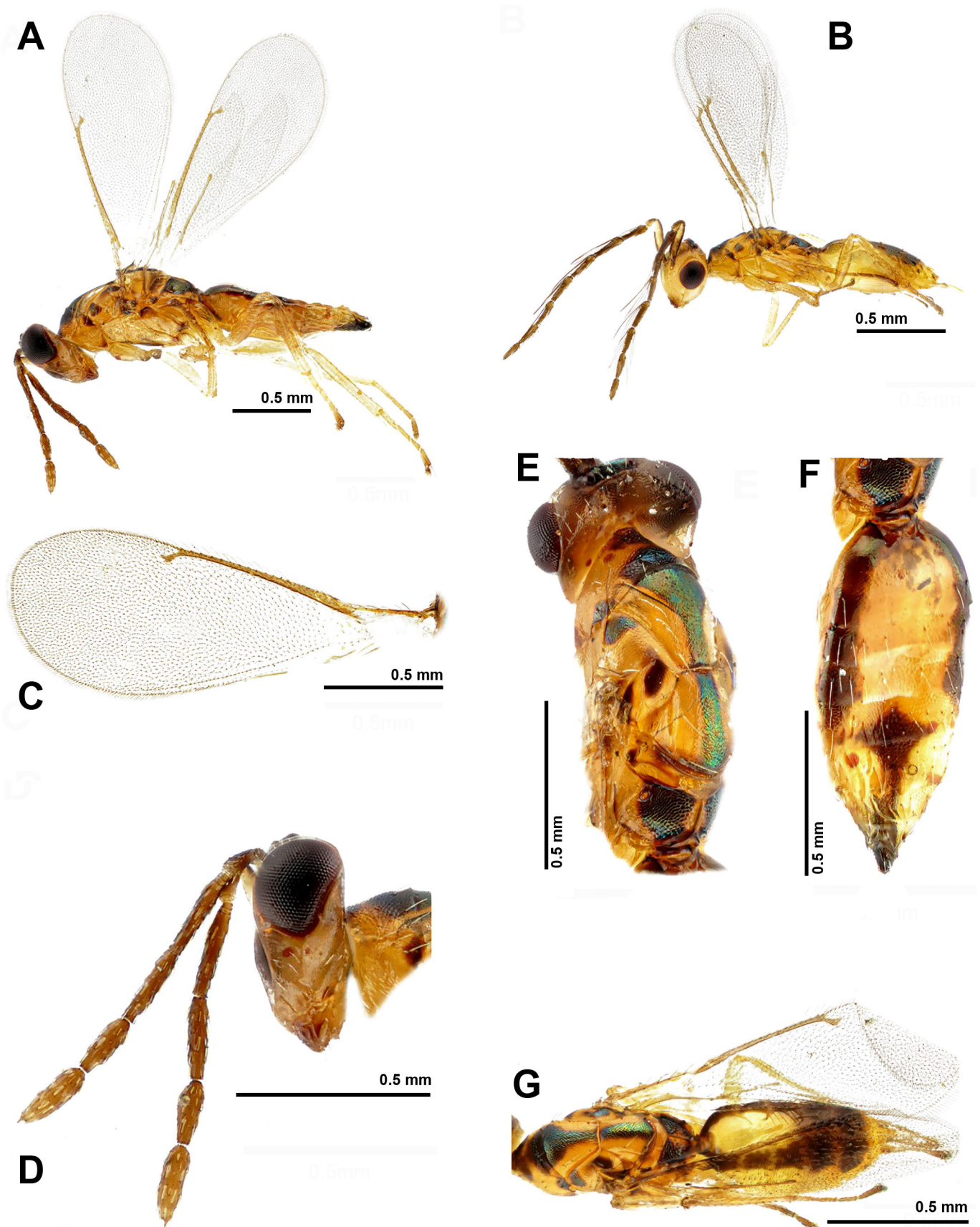


Figure 4. *Neotrichoporoides viridimaculatus* (Fullaway, 1955): **A.** General habitus, female, lateral view; **B.** General habitus, male, lateral view; **C.** Fore wing, female; **D.** Head and antennae, female, lateral view; **E.** Head and mesosoma, female, dorsal view; **F.** Propodeum and mesosoma, female, dorsal view; **G.** Mesosoma and metasoma, male, dorsal view.

Male. Similar to female except for antenna with inner surface of scape and all flagellum dark brown; scape comparatively longer, 1.3 times as long as eye (Fig. 4B). Gaster with lateral dark spots joining together at the middle, and the last tergites integrally have brown spots (Fig. 4B, 4G).

Distribution. Nearctic: USA (LaSalle, 1994); Neotropic: Argentina (Graham, 1987), Bermuda (De Santis & Fidalgo, 1994), Colombia (Domenichini, 1966), Cuba (De Santis, 1979); Oceania: Hawaii (Graham, 1987); Oriental: India (Narendran et al., 2006); Palaearctic: China (Zhu and Huang, 2001), Europe (UCD Community, 2023), Iran (Hesami et al., 2018), Iraq (**new record**), Turkey (Sakaltaş & Genç, 2005).

Key to the Iraqi species of the genus *Neotrichoporoides* Girault, 1913 (based on male)

- 1 In both female and male: Body mostly yellow (Fig. 4) with metallic green markings on meosoma and metasoma (Figs 4A, 4B, 4E, 4F, 4G); marginal vein more than 8× as long as stigmal vein (Figs 4A–C); malar sulcus with a small fovea just below the eye (Figs 4A, 4B, 4D); propodeum with only submedian area metallic green and dull (Figs 4E, 4G). *Neotrichoporoides viridimaculatus* (Fullaway, 1955)
 - Body mostly metallic green (Figs 2, 3); marginal vein at most 7× as long as stigmal vein (Figs 2A, 2C, 3A, 3C); malar sulcus with a large fovea below the lower margin of eye (Figs 2A, 2D, 3A, 3D); propodeum metallic green and shiny (Figs 2B, 3B, 3E). 2
- 2 Body with head (Figs 3A, 3B, 3D), mesosoma (Figs 3A–B) and metasoma (Figs 3A, 3E) completely metallic green; malar sulcus distinctly curved backward; Antennal scape 3× and pedicel 2.2× as long as wide (Figs 3A, 3D); mesoscutum with distinct median line and adnotaular setae arranged in one row (Fig. 3B). *Neotrichoporoides cavigena* Graham, 1987
 - Body with mesosoma metallic green (Figs 2A, 2B), but lower half of face (Figs 2A, 2D) and basal gastral tergites (Figs 2A, 2E) yellow; malar sulcus mostly straight to slightly curved at the end; antennal scape more than 4× and pedicel about 2× as long as wide (Figs 2A, 2D); mesoscutal median line absent, and adnotaular setae arranged in two rows (Fig. 2B). *Neotrichoporoides basiflavus* Li & Li, 2021

DISCUSSION

The genus *Neotrichoporoides* Girault, 1913 and all three species identified in the present study from Basra province in Iraq (Fig. 1) are new records for the fauna of Iraq. Furthermore, *N. basiflavus* Li & Li, 2021 is new for the West Palaearctic subregion. In Western Asia, *Neotrichoporoides cavigena* Graham, 1987 was previously reported only from Turkey (Sakaltaş & Genç, 2005), and this is the second report of this species. Including the species reported in the present study, the number of Iraqi species of Eulophidae increased to 15 species in 9 genera belonging to three subfamilies (Table 1). In total, 69 individuals of the collected specimens were male and 37 of them were female. Especially in the species *N. basiflavus* and *N. cavigena*, there is a male-biased collecting result which is most likely method-biased due to short-time sampling, quantity of sweeps, and sampling efforts (Santos & Fernandes, 2020; Rhainds & Heard, 2015). If the fieldwork is done regularly and frequently during the season, the possibility of male/female bias is reduced (Haris et al., 2024). The identification key prepared in the current research is based on males, but it can be used to identify females as well. Primary hosts of the identified species are unknown, except for *N. viridimaculatus* which has already been reported from *Pseudaletia unipuncta* (Lepidoptera, Noctuidae) (Peck, 1963). Although, most likely these wasps are endoparasitoids of Diptera (Graham, 1987). The plant association of *N. basiflavus* is unknown, and the other two have been reported so far only from Poaceae (Graham, 1987). Since many dipterous pests are present on alfalfa and cause significant damage (Spencer, 1973; Lotfalizadeh et al., 2015), and considering that *Neotrichoporoides* species are parasitoids of Diptera (Graham, 1987; UCD Community, 2023); it is suggested that further studies carried out on the biology of these newly reported wasps on alfalfa.

Table 1. List of recorded species of Eulophidae from Iraq (until August 1, 2024).

	Species	References
ENTEDONINAE		
1	<i>Neochrysocharis formosus</i> (Westwood, 1833)	Al-Azawi (1967, 1971)
2	<i>Pediobius metallicus</i> (Nees, 1834)	Al-Azawi (1967)
3	<i>Pediobius pyrgo</i> (Walker, 1839)	Awadallah et al. (1979a, 1979b)
EULOPHINAE		
4	<i>Cirrospilus vittatus</i> Walker, 1838	Al-Azawi (1971)
5	<i>Diglyphus crassinervis</i> Erdos, 1958	Al-Azawi (1971)
6	<i>Diglyphus isaea</i> (Walker, 1838)	Al-Azawi (1971)
7	<i>Pnigalio epilobii</i> Boucek, 1966	Mansowr et al. (2024)
8	<i>Pnigalio soemius</i> (Walker, 1839)	OILB (1971)
9	<i>Sympiesis flavopicta</i> Boucek, 1959	Bouček & Askew (1968)
10	<i>Sympiesis gregori</i> Boucek, 1959	Mansowr et al. (2024)
TETRASTICHINAE		
11	<i>Leptocybe invasa</i> Fisher & La Salle, 2004	Hassan (2012)
12	<i>Neotrichoporoides basiflavus</i> Li & Li, 2021	Present study
13	<i>Neotrichoporoides cavigena</i> Graham, 1987	Present study
14	<i>Neotrichoporoides viridimaculatus</i> (Fullaway, 1955)	Present study
15	<i>Oomyzus scaposus</i> (Thomson, 1878)	Swailen et al. (1975), Abdul-Rassoul (1976)

AUTHOR'S CONTRIBUTION

The authors confirm their contribution to the paper as follows: Z.F. Mansowr: Collecting the specimens, making the initial diagnosis, and drafting the manuscript; M. Jafarlu: Identification of the specimens to the species levels, drafting and revising the manuscript; H. Lotfalizadeh: Confirming the identifications, revising and editing the manuscript. The authors read and approved the final version of the manuscript.

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AVAILABILITY OF DATA AND MATERIAL

The specimens listed in this study are deposited in the insect collection of the Hayk Mirzayans Insect Museum (HMIM), Iranian Institute of Plant Protection, Tehran, Iran and are available from the curator, upon request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study only included arthropod material, and all required ethical guidelines for the treatment and use of animals were strictly adhered to in accordance with international, national, and institutional regulations. No human participants were involved in any studies conducted by the authors for this article.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

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

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اکتشاف جنس *Neotrichoporoides* (Hymenoptera, Eulophidae) Girault, 1913 در عراق به همراه سه گزارش جدید

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چکیده: طی تحقیقی که در مزارع یونجه (*Medicago sativa* L.) استان بصره در جنوب عراق طی سال ۱۴۰۰ به عمل آمد، با استفاده از تور حشره‌گیری، نمونه‌هایی جمع‌آوری شد. این نمونه‌ها همگی به جنس *Neotrichoporoides* Girault, 1913 از خانواده Eulophidae (Hymenoptera: Chalcidoidea) تعلق دارند که برای نخستین بار از عراق گزارش می‌شود. از این جنس سه گونه شامل *Neotrichoporoides basiflavus* Li & Li, 2021، *N. cavigena* Graham, 1987 و *N. viridimaculatus* (Fullaway, 1955) جمع‌آوری و شناسایی شد. کلید شناسایی مصور برای گونه‌های این جنس در عراق و نیز مشخصات مورفولوژیک مهم برای شناسایی آنها فراهم گردید. نقشه پراکنش گونه‌ها در عراق تهیه شد. بعلاوه لیست مقدماتی گونه‌های متعلق به خانواده Eulophidae تهیه شد.

واژگان کلیدی: Chalcidoidea، چک لیست، *Medicago sativa*، پارازیتوئید، رده بندی، Tetrastichinae