

Parasitoid wasps of the genus *Encarsia* Förster (Hymenoptera: Aphelinidae) in the Southern part of the Caspian Sea

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Abstract

A faunistic survey was carried out to study on parasitoid wasps of the genus *Encarsia* Förster in the southern part of the Caspian Sea during 2013-2016. In this study, 12 species of *Encarsia* were identified, of which *Encarsia gennaroi* Pedata & Giorgini, 2017 is newly recorded from Iran and six, three and two species are considered to be new records for the Mazandaran, Golestan and Guilan provinces, respectively. Several new host records for *Encarsia* species are also reported. Moreover, an identification key for the studied female specimens of *Encarsia* is provided. The identified *Encarsia* species are as follows: *E. aleurochitonis* (Mercet, 1931), *E. aurantii* (Howard), *E. azimi* Hayat, *E. berlesei* (Howard), *E. brimblecombei* (Girault), *E. citrina* (Craw), *E. fasciata* (Malenotti), *E. formosa* Gahan, *E. gennaroi* Pedata & Giorgini, *E. inaron* (Walker), *E. inquirenda* (Silvestri), *E. lutea* (Masi).

Key word: Identification key, Taxonomy, Guilan, Mazandaran, Golestan provinces

Encarsia Förster (Hymenoptera: Aphelinidae) زنبورهای پارازیتوئید جنس

حاشیه جنوبی دریای خزر

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چکیده

به منظور جمع‌آوری و شناسایی فون زنبورهای پارازیتوئید متعلق به جنس *Encarsia* Förster حاشیه جنوبی دریای خزر، مطالعاتی در فاصله سال‌های ۹۵-۱۳۹۳ انجام شد. در این بررسی ۱۲ گونه متعلق به این جنس جمع‌آوری و شناسایی شد که از این میان گونه *Encarsia gennaroi* Pedata & Giorgini, 2017 برای اولین بار از ایران گزارش می‌شود و شش گونه برای استان مازندران، سه گونه برای استان گلستان و دو گونه برای استان گیلان گزارش جدید هستند. همچنین، چندین گونه میزبان جدید برای این گروه از زنبورهای پارازیتوئید معرفی می‌شوند. علاوه بر این، کلید شناسایی برای گونه‌های جنس ماده *Encarsia* ارائه شده است. گونه‌های شناسایی شده شامل: *E. aleurochitonis* (Mercet, 1931)، *E. aurantii* (Howard)، *E. azimi* Hayat (Howard)، *E. berlesei* (Howard)، *E. brimblecombei* (Girault)، *E. citrina* (Craw)، *E. fasciata* (Malenotti)، *E. formosa* Gahan، *E. gennaroi* Pedata & Giorgini، *E. inaron* (Walker)، *E. inquirenda* (Silvestri) و *E. lutea* (Masi) هستند.

واژگان کلیدی: کلید شناسایی، تاکسونومی، استان گلستان، استان گیلان، استان مازندران

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Introduction

The southern part of the Caspian Sea, which is considered as a part of Hyrcanian geographical region, has a specific geographical location and climatic conditions. It includes dense forest, grassland and steppe. Hence, it is expected to be very rich in terms of insect fauna, especially the parasitoid wasps and their host species (Zarandian *et al.*, 2016). Parasitoids wasps are of paramount importance. Most of hymenopteran parasitoids are the members of three superfamilies, *i.e.* Ichneumonoidea, Chalcidoidea and Platygastroidea (Whitfield, 1998). Aphelinidae is one of the most important families of Chalcidoidea. The family includes small insects with the length of 0.6–1.4 mm and non-metallic color. They are usually yellow, grey, brown, black and/or combination of these colours is also seen (Hayat, 1989). So far, more than 40 genera have been recognized in Aphelinidae, of which the genus *Encarsia* Förster is a diverse genus with more than 450 species, which many of them remain unknown (Noyes, 2018). In Iran, Aphelinidae includes more than 67 species from 11 genera, of which 24 species belong to *Encarsia* (Modarres Aval, 1994; Lotfalizadeh, 2000; Fallahzadeha *et al.*, 2004; Shahbazvar *et al.*, 2010, Darsuei *et al.*, 2011; Basij *et al.*, 2012; Noyes, 2018). Different studies were done on Aphelinid wasps in Iran (eg: Kerukhin, 1946; Habibiyan, 1980; Rasekh, *et al.*, 2000). In 2000, Ostadalidehaghi studied the aphelinid parasitoids of Coccoidea on citrus trees in Guilan province and identified 13 species belonging to five genera, of which four species of *Encarsia* were reported for the first time from the province (Ostadalidehaghi, 2000). The parasitoid wasps of Coccoidea on citrus trees were also studied in Eastern area of Guilan province and *Encarsia inquirenda* (Silvestri, 1930) was reported for the first time in Iran (Jamalomidi *et al.*, 2012). The correct identification of these natural enemies is an important step in the biological control of scale insects and whiteflies. In the present study, the species of *Encarsia* from the southern part of the Caspian Sea were collected and identified. An identification taxonomic key to all studied female specimens of *Encarsia* is also provided.

Materials and methods

Reared material of *Encarsia* species from different parts of Guilan, Mazandaran, and Golestan provinces were studied. They were collected by rearing on their host species, such as scale insects (Hem.: Coccoidea) and whiteflies (Hem.: Aleyrodidae) under the laboratory conditions (25 ± 2 °C, RH = $70 \pm 10\%$ and a photoperiod of 16: 8 (light: dark)). Microscopic slides were prepared using the methods of Martin (1987), McKenzie (1956) and Polaszek (1997) for whiteflies, scale insects and parasitoids, respectively. Morphological terminology follows Hayat (1989). All specimens are collected by the first author and were deposited at Hayk Mirzayans Insect Museum (HMIM), Insect Taxonomy Research Department, Iranian

Research Institute of Plant Protection, Tehran, Iran and Insects collection at Department of Plant Protection, Faculty of Agricultural Sciences, University of Guilan, Rasht, Iran.

Results

In this study, 12 species of *Encarsia* were collected and identified. *Encarsia gennaroi* Pedata & Giorgini, 2017 is a new record for Iran and six, three and two species are newly reported from Mazandaran, Golestan and Guilan provinces, respectively. Also, eight scale insects and two whitefly species are considered as new hosts for some of these parasitoids as indicated below.

Key to the species of *Encarsia* (female)

- 1- Tarsal formula 5-4-5, mid lobe of mesoscutum with 18-20 setae, each side lobe with three setae.....*E. formosa*
 - Tarsal formula 5-5-5, mid lobe of mesoscutum and side lobes with different number of setae2
 2- Forewing with an asetose area around stigmal vein.....3
 - Forewing without an asetose area around stigmal vein.....4
 3- Mid lobe with 4 setae, antennal clava 3-segmented.....*E. citrina*
 - Mid lobe with 10-12 setae, antennal clava 2-segmented*E. gennaroi*
 4- Ovipositor very short, slightly longer than half the length of mid tibia.....*E. aurantii*
 - Ovipositor long, clearly much longer than half the length of mid tibia5
 5- Antennal formula 1,1,3,36
 - Antennal formula 1,1,4,211
 6- Mid lobe of mesoscutum with 4 setae.....7
 - Mid lobe of mesoscutum with more than 4 setae.....8
 7- Each side lobe with 1 seta, F1 shorter than F2 and F3 respectively... ..*E. fasciata*
 - Each side lobe with 2 setae, F1 equal to F2 and shorter than F3*E. inquirenda*
 8- Body largely yellow9
 - Body largely brown10
 9- Third valvula dark in striking contrast, each side lobe with 2-3 setae*E. lutea*
 -Third valvula yellow, each side lobe with one seta.....*E. aleurochitonis*
 10- F2 with 2 longitudinal sensilla, anterior margin of marginal vein with 5-6 setae
*E. brimblecombei*

- F2 without longitudinal sensilla, anterior margin of marginal vein with 8-9 setae*E. berlese*
 11- F1 longer than pedicle and with at least one longitudinal sensillum*E. inaron*
 - F1 shorter than pedicle and without longitudinal sensillum*E. azimi*

***Encarsia aleurochitonis* (Mercet, 1931)**

Material examined: Iran: Guilan province: 2♀, Masal, Gorab-e-zarmikh, (37°19'43" N, 49°14'2" E, 20 m), 5.9.2015, ex: *Aleurochiton acerinus* Haupt (Hem.: Aleyrodidae) on *Acer circinatum* (Aceraceae); 1♀, Sangar, Kochesfahan, Omsheh, (37°13'8.3" N, 49°42'53.6" E, 41 m), ex: *A. acerinus* on *A. circinatum* (Aceraceae); Mazandaran province: 2♀, Sari, Asrem, (36°36'47.7" N, 53°14'4.9" E, 60 m), 23.9.2013, ex: *A. pseudoplatani* Yisnya (Hem.: Aleyrodidae) on *A. circinatum* (Aceraceae); 1♀, Savadkoh, Alasht, (36°80'50" N, 53°12'7.5" E, 542 m), 12.10.2014, ex: *A. acerinus* on *A. circinatum* (Aceraceae).

Distribution: Finland, Germany, Italy, Russia, China and Iran (Noyes, 2018). This species is reported for the first time from Mazandaran and Guilan provinces.

Remark: *Aleurochiton acerinus* and *A. pseudoplatani* are considered as new host records for *E. aleurochitonis*.

***Encarsia aurantii* (Howard, 1894)**

Material examined: Iran: Golestan province: 1♀, Bandar-e-gaz, (36°45'41.2" N, 53°57'9.6" E, -2 m), 25.9.2015, ex: *Coccus hesperidum* L. (Hem.: Coccidae) on *Citrus medica* (Rutaceae); Guilan province: 1♀, Astara, Ghalamestan, (35°37'45.5" N, 51°24'46.8" E, 160 m), 25.9.2015, ex: *Chrysomphalus dictyospermi* (Morgan) (Hem.: Diaspididae) on *Citrus sinensis* (Rutaceae), 1♀, Astara, Lavandvil, Vizneh, (38°14'53.5" N, 48°52'57.4" E, 44 m), 25.9.2015, ex: *Unaspis euonymi* (Comstock) (Hem.: Diaspididae) on *Punica granatum* (Punicaceae), 1♀, Talesh, Kishdibi, Nalband, (37°48'13.5" N, 48°53'49.6" E, 101 m), 25.9.2015, ex: *C. hesperidum* on *Diospyros kaki* (Ebenaceae), 2♀, Hashtpar, Asalem, Khatjagil, (37°42'42.1" N, 48°54'29.8" E, 122 m), 25.9.2015, ex: *Ch. dictyospermi* on *Citrus aurantium* (Rutaceae), 14♀, Parrehsar, (37°35'35" N, 45°09'7.5" E, 14 m), 5.9.2015, ex: *Ch. dictyospermi* on *C. aurantium* (Rutaceae), 1♀, Parrehsar, Sheykh mahaleh, (37°28'46.7" N, 49°07'49" E, 86 m), 5.9.2015, ex: *Lepidosaphes gloverii* (Packard) (Hem.: Diaspididae) on *C. aurantium* (Rutaceae), 3♀, Masal, Tahergorab, (37°22'56.8" N, 49°13'41" E, 34 m), 5.9.2015, ex: *U. euonymi* on *Euonymus japonicus* (Celastraceae), 2♀, Fuman, Masoleh, Ashkalat, (37°90'47.1" N, 37°00'19.2" E, 833 m), 5.9.2015, ex: *C. hesperidum* on *Castanea sativa* (Fagaceae), 6♀, Rasht, Shaft, Ahmad sargorab, (37°08'4.4" N, 49°22'15.3" E, 36 m), 5.9.2015, ex: *C. hesperidum* on *Hibiscus rosa-sinensis* (Malvaceae), 3♀, Rasht, Shaft, Siyahmazgi, (37°02'0.6" N, 49°17'11.6" E, 3 m), 5.9.2015, ex: *Ch. dictyospermi* on

Cucurbita ficifolia (Cucurbitaceae), 2♀, Rasht, Shaft, Gourab -e- Zarmikh, (37°19'43" N, 49°14'02" E, 20 m), 8.XI.2015, ex: *Lepidosaphes pallida* (Maskell) (Hem.: Diaspididae) on *Ficus carica* (Moraceae).

Distribution: Cosmopolitan species (Noyes, 2018). In Iran: Fars and Guilan provinces (Lachiani & Ahmadi, 1993; Ostadalidehaghi, 2000). This species is a new record for Golestan province.

Remarks: In Iran, this species has already been reported from *Aonidiella orientalis* (Newstead) (Hem.: Diaspididae) (Lachiani & Ahmadi, 1993), *Parlatoria oleae* (Colvée) (Hem.: Diaspididae) and *Aonidiella aurantii* Maskell (Hem.: Diaspididae) (Ostadalidehaghi, 2000). *Unaspis euonymi*, *Coccus hesperidum* and *Lepidosaphes pallida* are reported as new hosts for *E. aurantii*.

***Encarsia azimi* Hayat, 1986**

Material examined: Iran: Mazandaran province: 12♀, Behshahr, Galogah, (36°41'54.5" N, 53°36'32.7" E, 40 m), 24.8.2015, ex: *Bemisia tabaci* (Gennadius) (Hem.: Aleyrodidae) on *Abutilon teophrasti* (Malvaceae).

Distribution: Australia, Canary Island, India, Italy, Japan, India, Spain, China, USA, Taiwan, Thailand (Noyes, 2018) and Iran (Fars province) (Ale-Mansour & Ahmadi, 1993). This species is reported for the first time from Mazandaran province.

Remark: This species was reported from *Bemisia tabaci* in Iran (Ale-Mansoor & Ahmadi, 1993).

***Encarsia berlesei* (Howard, 1906)**

Material examined: Iran: Guilan province: 2♀, Lahijan, Sarashkeh, (37°12'19" N, 49°54'17" E, 33 m), 28.8.2015, ex: *Pseudaulacaspis pentagona* (Targioni Tozzetti) (Hem.: Diaspididae) on *Morus alba* (Moraceae).

Distribution: Cosmopolitan species (Noyes, 2018). In Iran: Guilan province (Habibian, 1983).

Remark: This species was reported from *Pseudaulacaspis pentagona* in Iran (Habibian, 1983).

***Encarsia brimblecombei* (Girault, 1933)**

Material examined: Iran: Golestan province: 2♀, Kordkoy, Karkandeh, (36°46'53" N, 54°02'17" E, -12 m), 24.9.2015, ex: *Ch. dictyospermi* on *Phaseolus vulgaris* (Fabaceae); Guilan province: 5♀, Rudsar, Amlash, Kolkasara, (37°74'8.1" N, 50°16'05" E, 0 m), 7.8.2015, ex: *L. gloverii* on *C. sinensis* (Rutaceae), 3♀, Lahijan, Chofal, (37°10'11.9" N, 50°73'9.9" E, 33 m), 8.8.2015, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 1♀, Astara,

Ghalamestan, (35°37'45.5" N, 51°24'46.8" E, 160 m), 25.9.2015, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 3♀, Masal, Tahergorab, (37°22'56.8" N, 49°13'41" E, 34 m), 5.9.2015, ex: *U. euonymi* on *Euonymus japonicus* (Celastraceae), 2♀, Talesh, Gorganrod, (36°43'56" N, 48°54'9.4" E, 47 m), 4.7.2015, ex: *Ch. dictyospermi* on *Citrus granatum* (Rutaceae); Mazandaran province: 1♀, Nashtarod, Kotra, (36°43'12" N, 50°59'1" E, 37 m), 9.7.2015, ex: *Ch. dictyospermi* on *Citrus tangerina* (Rutaceae), 2♀, Ramsar, Gavramak village, (36°54'32.4" N, 50°37'4.4" E, 95 m), 7.8.2013, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 2♀, Sari, Farahabad, Safiabad, (36°40'38.3" N, 53°04'6.58" E, 5 m), 9.7.2015, ex: *C. hesperidum* on *C. sinensis* (Rutaceae).

Distribution: Argentina, Australia, France, India, USA, China, Italy, Spain (Noyes, 2018) and Iran (Guilan province) (Ostadalidehaghi, 2000). This species is a new record for Mazandaran province.

Remark: In Iran, this species has already been reported from *Lepidosaphes gloverii* (Modarres Awal, 1994; Ostadalidehaghi, 2000). *Chrysomphalus dictyospermi*, *Coccus hesperidum* and *Unaspis euonymi* are reported as new hosts for *E. brimblecombei*.

***Encarsia citrina* (Craw, 1891)**

Material examined: Iran: Golestan province: 10♀, Bandar-e-gaz, Nokandeh, (36°46'45.5" N, 53°56'46.6" E, -32 m), 25.9.2015, ex: *Aonidiella citrina* Coquillett (Hem.: Diaspididae) on *C. sinensis* (Rutaceae); Guilan province: 4♀, Chaboksar, Sarvellat, (36°59'22.7" N, 50°32'43.6" E, 1 m), 7.8.2014, ex: *Aspidiotus nerii* Bouché (Hem.: Diaspididae) on *Nerium oleander* (Oleaceae), 5♀, Rodsar, Amlash, Kolkasara, (37°74'8.1" N, 50°16'05" E, 1 m), 7.8.2015, ex: *L. gloverii* on *C. sinensis* (Rutaceae), 2♀, Langarod, Chamkhaleh, (37°91'3.9" N, 50°10'36.5" E, 21 m), 8.8.2015, ex: *U. euonymi* on *P. granatum* (Punicaceae), 3♀, Lahijan, Chofal, (37°10'11.9" N, 50°73'9.9" E, 33 m), 8.8.2015, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 5♀, Lahijan, Chofal, (37°10'11.9" N, 50°73'9.9" E, 33 m), 8.7.2015, ex: *L. pallida* on *C. sinensis* (Rutaceae), 2♀, Rostamabad, Totkabon, (36°53'47.7" N, 49°30'22" E, 260 m), 8.8.2015, ex: *Lepidosaphes japonica* (Kuwana) (Hem.: Diaspididae) on *Olea europae* (Oleaceae), 10♀, Astara, Gardaneh heyran, (38°23'38.9" N, 48°38'21.4" E, 550 m), 4.8.2015, ex: *L. gloverii* on *Diospyros* sp. (Ebenaceae), 2♀, Talesh, Kishdibi, Nalband, (37°48'13.5" N, 48°53'49.6" E, 101 m), 25.9.2015, ex: *C. hesperidum* on *D. kaki* (Ebenaceae), 2♀, Talesh, Gorganrod, 4.8.2015, (37°49'3.7"N, 48°54'9.4"E, 47 m), ex: *L. gloverii* on *C. granatum* (Rutaceae), 2♀, Hashtpar, Asalem, Kharjagil, (37°42'42.1" N, 48°54'29.8" E, 122 m), 25.9.2014, ex: *L. gloverii* on *C. aurantium* (Rutaceae), 1♀, Parrehsar, Sheykhmahaleh, (37°28'46.7" N, 49°07'49"E, 86 m), 5.10.2015, ex: *L. gloverii* on *C. aurantium* (Rutaceae), 3♀, Rasht, Shaft, Siyahmazgi, (37°02'0.6" N, 49°17'11.6" E, 3 m), ex: *Ch. dictyospermi* on *Cucurbita pepo* (Cucurbitaceae), 2♀, Sangar, Kochesfahan,

Omsheh, (37°11'39.1" N, 49°41'59.1" E, 43 m), 16.10.2015, ex: *L. gloverii* (Diaspididae) on *C. aurantium* (Rutaceae), 2♀, Sangar, Kochesfahan, Omsheh, (37°13'8.3" N, 49°42'53.6" E, 41 m), 19.10.2015, ex: *C. hesperidum* on *Acer circinatum* (Aceraceae), 3♀, Sangar, Lashtenesha, (37°21'34.3" N, 49°48'31.6" E, 11 m), 22.10.2014, ex: *A. citrina* on *C. sinensis* (Rutaceae); Mazandaran province: 20♀, Nashtarod, Kotra, (36°43'12" N, 50°59'01" E, 37 m), 9.7.2015, *Ch. dictyospermi* on *E. japonicus* (Celastraceae), 4♀, Nashtarod, Mazobonesofla, (36°04'43" N, 50°56'64.4" E, 66 m), 22.10.2014, *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 4♀, Ramsar, Khoramabad, Siyavaraz, (36°43'56" N, 50°55'05" E, 41 m), 9.7.2015, ex: *Ch. Dictyospermi* on *C. sinensis* (Rutaceae), 9♀, Nashtarod, Kheyrodkenar, Seyedalikiasoltan, (36°34'06" N, 51°34'31" E, 6 m), 6.8.2015, ex: *A. nerii* on *Nerium olendear* (Oleaceae), 2♀, Kelarabad, (36°40'41" N, 51°14'37" E, 12 m), 6.8.2015, ex: *Lopholeucaspis japonica*(Cockerell) (Hem.: Diaspididae) on *Alnus subcordata* (Betulaceae), 1♀, Rasht, Sarawan, (37°01'50.7" N, 49°38'11.9" E, 41 m), 20.10.2016, ex: *L. pallida* on *Ficus carica* (Moraceae).

Distribution: Cosmopolitan species (Noyes, 2018). In Iran: Guilan and Mazandaran provinces (Farahbakhsh, 1961; Ostadalidehaghi, 2000; Rasekh *et al.*, 2000). This species is reported for the first time from Golestan province.

Remark: In Iran, this species has already been recorded from *Aonidiella aurantii* Maskell (Hem.: Diaspididae) (Ostadalidehaghi, 2000), *Nuculaspis abietis* (Schrank) (Hem.: Diaspididae), *Aonidella citrina* (Coquillett) (Hem.: Diaspididae) and *Ch. dictyospermi* (Farahbakhsh, 1961; Rasekh *et al.*, 2000). *Coccus hesperidum* and *Lepidosaphes pallida* are reported as new hosts for *E. citrina*.

***Encarsia fasciata* (Malenotti, 1917)**

Material examined: Iran: Mazandaran province: 1♀, Ramsar, Khoramabad, Siyahvaraz, (36°43'56" N, 50°55'5" E, 41 m), 2.7.2015, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 1♀, Noshahr, Kheyrodkenar, Najardeh, Bandepey, (36°21'0" N, 52°29'0"E, 48 m), 10.10.2015, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae).

Distribution: France, Japan, USA, Spain, China, France, Germany, Italy (Noyes, 2018) and Iran (Guilan province) (Farahbakhsh, 1961; Ostadalidehaghi, 2000). This species is newly reported from Mazandaran province.

Remark: This species has already been reported from *Ch. dictyospermi* (Ostadalidehaghi, 2000), *Aonidiella aurantii* and *Aonidella citrina* (Farahbakhsh, 1961) in Iran.

***Encarsia formosa* Gahan, 1924**

Material examined: Iran: Golestan province: 4♀, Kordkoy, Karkandeh, (36°46'53" N, 54°21'7" E, -12 m), 25.10.2015, ex: *B. tabaci* on *Ph. vulgaris* (Fabaceae); Guilan province:

3♀, Rasht, Pirbazar, (37°20'12.1"N 49°33'21.8"E -8 m), 20.9.2015, ex: *Trialeurodes vaporariorum* Westwood (Hem.: Aleyrodidae) on *Cucumis sativa* (Cucurbitaceae), 5♀, Emamzadeh hashem, Sarawan, (37°15'0.7"N 49°38'11.9"E 41 m), 20.10.2014, ex: *T. vaporariorum* on *A. theophrasti* (Malvaceae), 2♀, Sari, Asrem, (36°36'47.7" N, 53°14'4.9" E, 60 m), 24.6.2014, ex: *B. tabaci* on *P. vulgaris* (Fabaceae).

Distribution: Cosmopolitan species (Noyes, 2018). In Iran: Guilan, Isfahan, Markazi and Lorestan provinces (Shahbazvar *et al.*, 2010; Behdad, 1988; Abolmasoumi *et al.*, 2009).

Remark: This species has already been reported from *Bemisia tabaci* and *Trialeurodes vaporariorum* (Behdad, 1988; Shahbazvar *et al.*, 2010; Abolmasoumi *et al.*, 2009) in Iran.

***Encarsia gennaroi* Pedata & Giorgini, 2017**

(Fig 1. A-F)

Material examined: Iran: Guilan province: 2♀, Lahijan, Chofal, (37°10'11.9"N, 50°73'39.9"E, 33 m), 8.8.2015, ex: *T. vaporariorum* on *C. sativa* (Cucurbitaceae), 4♀, Sangar, Kochesfahan, Omsheh, (37°13'8.3" N, 49°42'53.6" E, 41 m), 12.10.2015, ex: *T. vaporariorum* (Aleyrodidae) on *C. fiofolia* (Cucurbitaceae), 3♀, Lashtenesh, Khoshkebijar, Jorkoye, (37°21'50.4" N, 49°46'55.2" E, 5 m), 20.10.2016, ex: *T. vaporariorum* on *C. fiofolia* (Cucurbitaceae), 5♀, Sarawan, (37°1'50.7" N, 49°38'11.9" E, 41m), 20.10.2016, ex: *T. vaporariorum* on *A. theophrasti* (Malvaceae), 5♀, Rasht, Shaft, Siyahmazgi, (37°2'0.6" N, 49°17'11.6" E, 3 m), 5.9.2015, ex: *Bemisia tabaci* on *Cucurbita ficifolia* (Cucurbitaceae), 3♀, Rasht, Shaft, Siyahmazgi, (37°2'0.6" N, 49°17'11.6" E, 3 m), 5.9.2015, ex: *B. tabaci* on *Clerodendrum bungei* (Laminaceae), 3♀, Fuman, Masoleh, Kolarm village, (37°12'5.6"N, 49°12'52.5" E, 119 m), 9.9.2015, ex: *B. tabaci* on *Cucurbita* sp. (Cucurbitaceae), 8♀, Fuman, Masoleh, Sikhbon, (37°10'2.4"N, 49°5'2.5" E, 381 m), 8.9.2015, ex: *T. vaporariorum* on *C. pepo* (Cucurbitaceae), 2♀, Masal, Gorab-e-zarmikh, (37°19'43" N, 49°14'2" E, 20 m), 5.6.2015, ex: *B. tabaci* on *C. sativa* (Cucurbitaceae), 2♀, Sangar, (37°11'48.7" N, 49°39'32.5" E, 43 m), 20.10.2016, ex: *T. vaporarioum* on *Cucurbita* sp. (Cucurbitaceae); Mazandaran province: 9♀, Haraz roud, Narenjestan, (36°17'50" N, 52°22'19.7"E, 357 m), 23.7.2014, ex: *T. vaporariorum* on *Urtica incisa* (Urticaceae), 1♀, Mahmoud abad, Darya sar, (36°27'48" N, 52°07'50" E, -9 m), 23.7.2014, ex: *T. vaporariorum* on *U. incisa* (Urticaceae), 3♀, Behshahr, Galogah, (36°41'54.5" N, 53°36'32.7"E, 40 m), 24.9.2015, ex: *B. tabaci* on *A. theophrasti* (Malvaceae), 2♀, Ghaemshahr, Molkkola, (36°26'19.6" N, 52°50'28"E, 85m), 24.9.2015, ex: *B. tabaci* on *Nerium olender* (Oleaceae).

Diagnosis: (Female) Head and mesosoma mostly yellow, antenna yellow, dorsal metasoma brown, except seventh abdominal tergite yellow, legs yellow. Fore wing hyaline, infuscated below marginal vein and with an asetose area around stigmal vein, marginal vein with five to six setae, basal cell with one seta. Antennal formula 1,1,4,2, pedicel shorter than F1,

F2–F4 increasing in length, F5 shorter than F6. Mid lobe of mesoscutum with 10 to 12 setae, each side lobe of mesoscutum with one setae. One pair of setae on the sixth gastral tergite. Ovipositor usually shorter than mid tibia, ratio of second valvula to third valvula equal or more than 1.53, ratio of ovipositor to second valvula equal or less than 1.66. Ratio of F3 length to midbasitarsus equal or less than 0.62, ratio of midtibia to forewing length equal or more than 0.33 (Gebiola *et al.*, 2017).

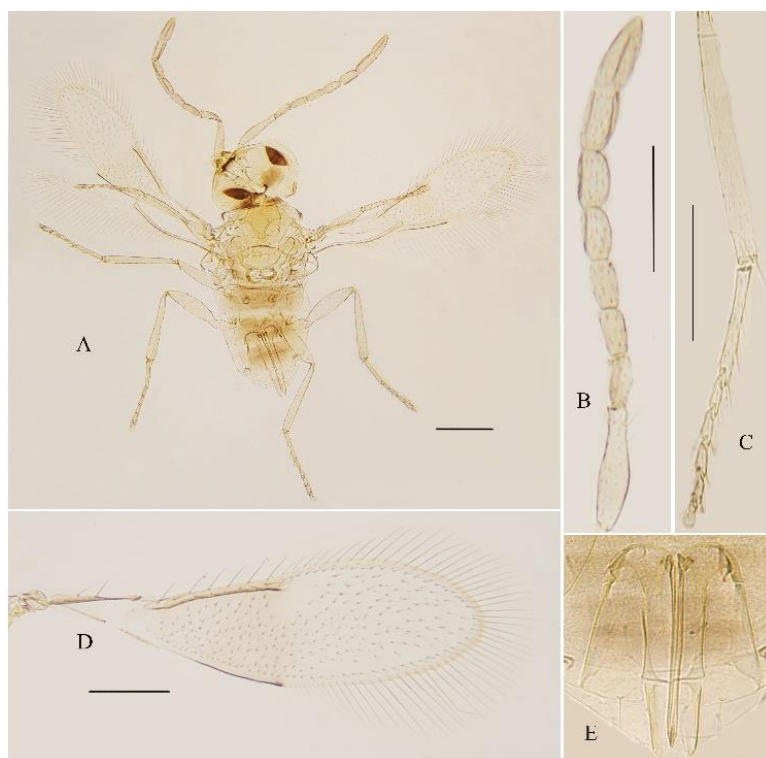


Fig. 1. *Encarsia gennaroi* female. A) Habitus, B) Antenna, C) Midtibia and Basitarsus, D) Forewing, E) Ovipositor. Scale bar = 0.01 mm.

Distribution: USA, Italy, France, Spain, Egypt, Canary Island, Australia (Noyes, 2018). This species is newly recorded from Iran.

Remark: All the host-reared examined specimens were identified as *E. gennaroi*. But about ten specimens showed all diagnostic characters of *E. gennaroi* except the number of setae on the sixth abdominal tergite; *i.e.* they have two pairs of setae on this tergite (one specimen with three setae) comparing to one pair in a typical *E. gennaroi*. According to Gebiola *et al.* (2017), all species in *Encarsia pergandiella* species complex have one pair of setae on the sixth abdominal tergite except *Encarsia marthae* Pedata & Giorgini which has two pairs. In this case, those mentioned specimens could be considered as a new species; however, we believe, this character could be considered as an intraspecific variation among studied specimens. Thus, it is suggested to collect and examine more specimens to find out if it is stable enough at species-level (Andrew Polaszek, personal communication). Additionally, a

molecular study using DNA Barcoding method (COI gene) is needed to compare the sequences for the two pairs versus one pair setae for several individuals of *E. gennaroi*.

***Encarsia inaron* (Walker, 1839)**

Material examined: Iran: Golestan province: 4♀, Kordkoy, Karkandeh, (36°46'53" N, 54°21'7" E, -12 m), 25.9.2014, ex: *B. tabaci* on *Ph. vulgaris* (Fabaceae), 4♀, Kordkoy, Karkandeh, (36°46'53" N, 54°02'17" E, -12 m), 25.5.2015, ex: *T. vaporariorum* on *Ph. Vulgaris* (Lamiaceae); Guilan province: 1♀, Rasht, Pirbazar, (37°20'12.1" N, 49°33'21.8" E, -8 m), 20.10.2015, ex: *T. vaporariorum* on *C. sativa* (Cucurbitaceae), 10♀, Emamzadeh hashem, Sarawan, (37°15'0.7" N, 49°38'11.9" E, 41 m), 20.10.2014, ex: *T. vaporariorum* on *A. teophrase* (Malvaceae); Mazandaran province: 4♀, Galogah, Rostamkola, (36°41'7.9" N, 53°25'50.7" E, 30 m), 20.10.2014, ex: *Siphoninus phillyreae* (Haliday) (Hem.: Aleyrodidae) on *P. granatum* (Punicaceae), 2♀, Sari, Asrem, (36°36'47.7" N, 53°14'9.4" E, 60 m), 24.8.2015, ex: *A. pseudoplatani* on *A. circinatum* (Aceraceae), 10♀, Chalous road, Aykan, (36°39'75.7" N, 53°24'67.4" E, 78 m), 13.7.2015, ex: *Aleyrodes prototella* L. (Hem.: Aleyrodidae) on *Rosa* sp. (Rosaceae), 1♀, Nowshahr, Kheyrodkenar, Najardeh, (36°36'31" N, 51°34'19.4" E, 50 m), 6.8.2015, ex: *S. phillyreae* on *P. granatum* (Punicaceae), 3♀, Tonekabon, Siyavaraz, (36°43'54" N, 50°56'39.4" E, 41 m), 7.8.2015, ex: *S. phillyreae* on *P. granatum* (Punicaceae).

Distribution: Cosmopolitan species (Noyes, 2018). In Iran: Fars, Guilan, Khosestan, Lorestan and Markazi provinces (Ale-Mansour & Ahmadi, 1993; Shahbazvar *et al.*, 2010; Minaeimoghadam *et al.*, 2012; Abolmasoumi *et al.*, 2009).

Remark: In Iran, this species has already been reported from *B. tabaci* (Ale-Mansoor & Ahmadi, 1993), *T. vaporariorum* (Shahbazvar *et al.*, 2010), *Aleyrodes singularis* (Abolmasoumi *et al.*, 2009) and *Neomaskellia andropogonis* (Minaeimoghadam *et al.*, 2012).

***Encarsia inquirenda* (Silvestri, 1930)**

Material examined: Iran: Golestan province: 3♀, Bandar-e-Torkman, Ashoradeh, (36°53'56.9" N, 54°4'5.5" E, -15 m), 7.8.2014, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae); Guilan province: 3♀, Chaboksar, Sarwelat, (36°59'22.7" N, 50°32'43.6" E, 1 m), 8.7.2015, ex: *A. nerii* on *N. oleander* (Oleaceae), 5♀, Rodsar, Amlash, Kolkasara, (37°74'8.1" N, 50°16'5" E, 1 m), 8.7.2015, ex: *L. gloverii* on *C. sinensis* (Rutaceae), 3♀, Lahijan, Chofal, (37°10'11.9" N, 50°73'9.9" E, 33 m), 8.7.2014, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 5♀, Lahijan, Deylaman, Balarod, (37°23'4.9" N, 49°53'56.8" E, 256 m), 8.7.2014, ex: *Ch. dictyospermi* on *Ruscus hircanus* (Asparagaceae), 2♀, Rostamabad, Totkabon, (36°53'47.7" N, 49°30'22" E, 260 m), 17.6.2014, ex: *L. japonica* on *O. europae* (Oleaceae), 3♀, Hashtpar, Asalem, Kharjagil, (37°42'42.1" N, 48°54'29.8" E, 122 m),

25.9.2015, ex: *Ch. dictyospermi* on *C. aurantium* (Rutaceae), 3♀, Masal, Tahergorab, (37°22'56.8" N, 49°13'41" E, 34 m), 7.7.2015, ex: *U. euonymi* on *E. japonicus* (Celastraceae), 1♀, Sangar, Lashtenesha, (37°21'34.3" N, 49°48'31.6" E, 11 m), 20.10.2015, ex: *A. citrina* on *C. sinensis* (Rutaceae); Mazandaran province: 1♀, Chalous, Alefkola, (36°40'39.1"N, 51°23'50.4"E, 2 m), 9.7.2015, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 1♀, Nashtarod, Kotra, (36°12'43" N, 50°59'1" E, 37 m), 9.7.2014, ex: *Ch. dictyospermi* on *C. tangerina* (Rutaceae), 2♀, Ramsar, Khoramabad, Siyavaraz, (36°43'56" N, 51°20'37" E, 41 m), 9.7.2014, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 4♀, Nashtarod, Khoshkedaran, (36°45'15" N, 51°0'37" E, 19 m), 7.9.2014, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 1♀, Mahmoudabad, Lamizdeh, (36°32'26.9" N, 52°19'5.9" E, 363 m), 23.7.2014, ex: *U. euonymi* on *E. japonicus* (Diaspididae), 2♀, Mahmoudabad, Daryasara, (36°27'48" N, 52°01'75" E, -9 m), 28.6.2014, ex: *L. pallida* on *A. circulantum* (Aceraceae), 1♀, Nowshahr, Kheyrodkenar, Najardeh, Bandepey, (36°21'0" N, 52°29'0" E, 48 m), 31.8.2014, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 3♀, Ramsar, Siyavaraz, Tashgon, (36°44'2.25" N, 50°54'0.2" E, 51 m), 13.6.2014, ex: *U. euonymi* on *E. japonicus* (Diaspididae), 2♀, Ramsar, Gavramak village, (36°54'32.4" N, 50°37'4.6" E, 95 m), 4.4.2014, ex: *Ch. dictyospermi* on *C. sinensis* (Rutaceae), 7♀, Savadkoh, Shirgah, (36°18'28.6" N, 52°53'10"E, 544 m), 20.2.2013, ex: *L. glovii* (Diaspididae) on *C. sinensis* (Rutaceae).

Distribution: China, Italy, Japan, Spain, Vietnam (Noyes, 2018) and Iran (Guilan province) (Jamalomidi *et al.*, 2012). This species is reported for the first time from Mazandaran and Golestan provinces.

Remark: In Iran, this species has already been recorded from *Lepidosaphes beckii*, *Lepidosaphes gloverii* and *Ch. dictyospermi* (Jamalomodi *et al.*, 2012). *Aspidiotus nerii*, *Aonidiella citrina*, *Lepidosaphes japonica*, *Lepidosaphes pallida* and *Unaspis eunymi* are reported as new hosts for *E. inquirenda*.

***Encarsia lutea* (Masi, 1909)**

Material examined: Iran: Golestan province: 4♀, Kordkoy, Karkandeh, (36°46'53" N, 54°21'7" E, -12 m), 4.V.2014, ex: *B. tabaci* on *Ph. vulgaris* (Fabaceae), 2♀, Bandar-e-gaz, Nokandeh, Telour, (36°44'47" N, 53°53'41.7"E, -6 m), 8.IX.2014, ex: *B. tabaci* on *Urtica dioica* (Urticaceae); Mazandaran province: 3♀, Behshahr, Galogah, (36°41'54.5"N, 53°36'32.7" E, 40 m), 6.VII.2016, ex: *B. tabaci* on *A. theophrasti* (Malvaceae).

Distribution: Cosmopolitan species (Noyes, 2018). In Iran: Golestan and Fars provinces (Karimian, 2004; Ale-Mansour & Ahmadi, 1993).

Remark: This species has been reported from *Bemisia tabaci* (Ale-Mansoor & Ahmadi, 1993; Karimian, 2004) in Iran.

Discussion

More than 20 species of *Encarsia* have hitherto been reported from Iran (Noyes, 2018), of which about 25% are distributed in three northern provinces adjacent to the Caspian Sea. This is most likely due to suitability of climatic conditions for whiteflies and scale insects as the main hosts of *Encarsia* species.

In the course of a three-year sampling program in the studied areas, it is concluded that *Encarsia* species are active from late February through October, however those *Encarsia* species which parasitizes whiteflies appear to start their activities from early June. Our observations indicated that the scale insect and whitefly species collected in lower altitudes (less than 100 m above sea level), on the same host plants, were more vulnerable to the attacks by *Encarsia* species. The majority of parasitized scale insects were collected on citrus trees. Our result indicated that three *Encarsia* species, viz. *E. brimblecombei*, *E. citrina* and *E. inquirenda*, were dominant than other species. According to the literature, about 30 species of *Encarsia* have been reported from the countries neighbor to the Caspian Sea such as, Azarbaijan, Russia, Kazakhstan and Türkmenistan (Yasnosh, 1989; Myartseva, 1996; Mustafayeva, 2016; Noyes, 2018), of which 14 species also occur in Iran, including the eight species collected in the current study, viz. *E. aleurochitonis*, *E. aurantii*, *E. berleseii*, *E. citrina*, *E. fasciata*, *E. formosa*, *E. inaron* and *E. lutea*. This faunal similarity may be attributed to the fact that some factors, such as climatic conditions and host plants, are almost the same in the studied area and those countries adjacent to the Caspian Sea.

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