

Hymenopterous parasitoids of safflower seed pests in Iran

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Abstract

Four species of fruit flies (Dip.: Tephritidae), *Acanthiophilus helianthi* (Rossi), *Chaetorellia carthami* Stackelberg, *Terellia luteola* (Wiedemann), *Urophora mauritanica* Macquart, and the safflower gall wasp, *Isocolus tinctorius* Melika & Gharali (Hym.: Cynipidae) are serious pests of safflower fields in Iran. Twelve species of hymenopterous parasitoids of these pests were reared and some of their morphological and biological data were presented. These parasitoids belong to the families Eulophidae, Eurytomidae, Ormyridae, Pteromalidae, Torymidae (Hym.: Chalcidoidea) and Braconidae. Two species, *Pronotalia carlinarum* (Szelényi & Erdös) (Eulophidae) and *Pteromalus albipennis* Walker (Pteromalidae) are recorded for the first time from Iran. Association of *Bracon luteator* Spinola, *Colotrechnus viridis* (Masi), *Microdontomerus annulatus* (Bouček), *Pronotalia carlinarum*, and *Pteromalus albipennis* with safflower fruit flies, and the association of *Ormyrus gratusus* (Förster) (Hym.: Ormyridae) with the safflower cynipid gall wasp are newly recorded. An illustrated key is provided for the adult parasitoids.

Key words: Hymenoptera, safflower pest, fruit flies, gall wasp, Iran.

زنبورهای پارازیتوید آفات بذرخوار گلرنگ در ایران

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چکیده

مگس‌های گلرنگ *Acanthiophilus helianthi* (Rossi)، *Chaetorellia carthami* Stackelberg، *Terellia luteola* (Wiedemann) و *Urophora mauritanica* Macquart متعلق به خانواده‌ی Tephritidae و زنبور گال‌زای گلرنگ *Isocolus tinctorius* Melika & Gharali از خانواده‌ی Cynipidae از آفات مهم این محصول در مزارع گلرنگ ایران می‌باشند. در این بررسی ۱۲ گونه زنبور پارازیتوید از روی این آفات پرورش داده شد و خصوصیات مورفولوژیک و بیولوژیک آنها ارایه گردید. این پارازیتویدها متعلق به خانواده‌های Braconidae، Eulophidae، Eurytomidae، Ormyridae، Pteromalidae و Torymidae بودند. گونه‌های *Pronotalia carlinarum* (Szelényi & Erdös) از خانواده‌ی Eulophidae و *Pteromalus albipennis* Walker از خانواده‌ی Pteromalidae برای نخستین بار از ایران گزارش می‌شوند. ارتباط بیولوژیک گونه‌های *Bracon luteator* Spinola، *Colotrechnus viridis* (Masi)، *Microdontomerus annulatus* (Bouček)، *Pronotalia carlinarum* و *Pteromalus albipennis* با مگس‌های گلرنگ و ارتباط بیولوژیک زنبور پارازیتوید *Ormyrus gratusus* (Förster) از خانواده Ormyridae با زنبور گال‌زای گلرنگ برای نخستین بار گزارش می‌شود. برای گونه‌های پرورش داده شده در این تحقیق کلید شناسایی مصور فراهم گردید. واژه‌های کلیدی: بال غشاییان، آفات گلرنگ، مگس‌های میوه، زنبورهای گال‌زا، ایران.

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Introduction

Safflower (*Carthamus tinctorius* L.) is a thistle-like plant, well adapted to dry climates. It is an annual broadleaf crop which is traditionally grown for its oil rich seeds and is also used for food flavoring and food coloring (Oelke *et al.* 2008). Although safflower is affected by a number of insect pests, only a few of them are economically important in some parts of the world. In India, 25 pest species were found of economic importance (Singh *et al.* 1999) and 23 insect species were found feeding on safflower in Karnataka, India (Balikai, 2000). The safflower aphid, *Uroleucon compositae* (Theobald) (Hem.: Aphididae) is the major pest, which causes 30 to 80 percent yield loss depending on weather conditions in India (Hanumantharaya *et al.* 2008). *Thrips tabaci* Lindeman, *Trypanea eluta* (Meigen) and *Oxycarenus hyalinipennis* (Costa) (Hem.: Oxycarenidae) were the main insects infesting safflower in Mansoura, Egypt (Ragab, 1991). Many species of insects are found in safflower fields in Iran, especially capitulum-damaging insects (Gharali, 2004a, b; Saeidi and Adam, 2011) such as safflower fruit flies (Dip.: Tephritidae). Other pests include *Heliothis peltigera* Den & Shi (Lep.: Noctuidae), *Tetranychus urticae* Koch (Acari: Tetranychidae) and *Oxycarenus pallens* Herrich-Schaeffer (Hem.: Lygaeidae) in Iran (Khanjani, 2008). Freidberg and Kugler (1989) recorded two fruit flies *Acanthophilus helianthi* (Rossi) and *Chaetorellia carthami* Stackelberg as the pests of safflower flowerheads that larvae feed on the flower heads of *Carthamus tinctorius* (safflower), *C. tenuis* and *Centaurea* sp. in Israel.

Safflower fruit flies represent as key pests of safflower fields, because of its direct damage on seeds. It causes more than 50% damage of seeds in Iran and its chemical control is the single practical treat (Pasban-Eslam, personal communication).

Within the family Tephritidae, safflower fruit flies feed on receptacles and seeds, and they can reduce the yield, seriously (Abbas *et al.* 1977; Singh *et al.* 1999; Gharali, 2004a). Safflower fruit flies in Iran represented by a group of tephritids, including *Acanthophilus helianthi* (Rossi), *Chaetorellia carthami* Stackelberg, *Terellia luteola* (Wiedemann), and *Urophora mauritanica* Macquart (Gharali, 2004a). Among these species, *A. helianthi* is the most serious

pest of safflower not only in Iran, but also throughout the world (Bagheri and Nematollahi, 2006; Saeedi, 2006; Merz and Blasco-Zumeta, 1995; Kutuk, 2008; Freidberg, 1996). It is widely distributed in the Palaearctic (most of Europe, Transcaucasica, Near East, Central Asia and East Palaearctic), North Afrotropical and Oriental regions (Abbas *et al.* 1977; Al-Ali *et al.* 1979; Merz and Blasco-Zumeta, 1995; Kutuk, 2008; Freidberg, 1996). Its biology has been studied in various geographical regions in Iran (Bagheri and Nematollahi, 2006; Saeedi, 2006). Pesticide application is the most practical methods against these pests but this treatment reduces overall insect's diversity and cumulates in the extracted oil that menace human safety (Hanumantharaya *et al.* 2008; Oelke *et al.* 2008).

Acanthophilus helianthi attacks a wide range of host plant species the tribe Cardueae (Asteraceae) (Merz and Blasco-Zumeta, 1995). The yellow safflower-fly, *C. carthami* is known to be a pest of safflower in western Asia and northern Africa (Al-Ali *et al.* 1979; Freidberg and Kugler, 1989). *Terellia luteola* and *U. mauritanica* are distributed in the Mediterranean region feeding on *Carthamus* species (Merz and Blasco-Zumeta, 1995). Gharali (2004b) has studied the biology of *U. mauritanica* as a pest of safflower fields in the western part of Iran. Moreover, the safflower gall wasp, *Isocolus tinctorius* Melika & Gharali was originally described in Iran (Ilam Province), as a potential pest of safflower (Melika and Gharali, 2006). However, Gharali and Zerova (2004) indicated that the population of this insect is currently under control by various parasitoids.

Up to now, a few papers have been published about safflower pests and their parasitoids in Iran (Gharali and Zerova, 2004; Bagheri and Nematollahi, 2006; Saeedi, 2006). Gharali (2004a) listed the natural enemies of safflower fruit flies in Ilam Province. Moreover, Gharali and Zerova (2004) reported three different species of parasitoids reared from the galls of *Isocolus tinctorius*. Identification of natural enemies can help to find effective species because they could diminish the reliance on chemicals, which in many cases reduce beneficial insect populations such as pollinators and natural enemies (Oelke *et al.* 2008).

In spite of the wide distribution of safflower fruit fly pests, there are no comprehensive studies about parasitoids of

these pests in Iran. This is the first review of parasitoids of safflower pests. We also provided an identification key for the hymenopterous parasitoids of safflower seed pests in Iran.

Materials and Methods

Insect samples were collected during summers 2003 to 2009 from four provinces of Iran including: Chaharmahal-e-Bakhtiari (in the west), East-Azarbaijan (in the northwest), Ilam (in the west) and Isfahan (in the Centre).

The safflower fields (*Carthamus tinctorius*) with minimum insecticides application were investigated and the infested capitula were collected. Collected material in each date and locality put in separate containers and were kept in laboratory controlled condition ($25\pm 2^{\circ}\text{C}$, 60% RH, 14:8, L:D) until parasitoids emerged. The capitula of wild safflowers, *Carthamus oxycantus* M. Bieb. and *C. lanatus*, were also collected around the safflower fields. Reared parasitoids were mounted on point cards following Noyes (1982).

All Iranian records of parasitoids on safflower pests were included in a dichotomous key with illustrations for each species. The key is based on adult morphology. Morphological terminologies follow Lotfalizadeh *et al.* (2007). Photographs were made using a stereomicroscope Olympus SZH equipped with a Canon A720 digital camera installed on an ocular tube.

Results and Discussion

The results showed that insect pests on capitulum of safflower in Iran include four species of fruit flies (Dip.: Tephritidae) and one species of gall wasp (Hym.: Cynipidae). *Acanthiophilus helianthi* (Fig. 1A, B), the most economically important harmful species, along with three other species (Gharali, 2004a) were hosts to several hymenopterous parasitoids. The majority of these parasitoid wasps belong to the superfamily Chalcidoidea (families Eulophidae, Eurytomidae, Ormyridae, Pteromalidae and Torymidae) (Table 2). Three species belonged to the family Braconidae (superfamily Ichneumonoidea). All species, except *Pachyneuron muscarum* (L.), have been recorded as parasitoids of different stages of fruit flies on *Carthamus tinctorius*, *Carthamus oxycantus* and *C. lanatus* hosts. Only the four families Eurytomidae, Eulophidae, Ormyridae, and

Torymidae have been previously reared as parasitoids of *A. helianthi* (Hegazi and Moursi, 1983; Narendarn, 1994; Noyes, 2012). Within the listed species, *Pteromalus albipennis* Walker (Hym.: Chalcidoidea, Pteromalidae) and *Pronotalia carlinarum* (Szelényi and Erdős) (Hym.: Chalcidoidea, Eulophidae) are new records for Iranian fauna. Biological association of *P. albipennis* with safflower fruit flies is also new.

Key to the hymenopterous parasitoids of safflower seed pests in Iran

- 1- Fore wing with longitudinal and cross veins and several closed cells (Fig. 1E); antenna filiform with more than 15 segments (Fig. 2A) **2 (Braconidae)**
 - Fore wing venation reduced and without closed cell (Figs 1F-H); antenna elbowed between the scape and pedicel with less than 15 segments (Figs. 1D, 2F, 3C)..... **4 (Chalcidoidea)**
 2. Antenna short, not longer than mesosoma or slightly so, female antennae 13-18 segmented; vein 1-SR of fore wing absent or nearly so; second submarginal cell of fore wing hardly longer than wide; ovipositor sheath much shorter than body; metasoma smooth..... **3**
 - Antenna moderately long, distinctly longer than mesosoma, female antennae 25-34 segmented; vein 1-SR of fore wing present; second submarginal cell of fore wing much longer than wide (Fig. 1E); ovipositor sheath about as long as body; metasoma sculptured *B. luteator*
 3. Antenna of female with 13-14 (15) segments; setae of head erect, reaching above level of upper level of posterior ocelli; vein 3-SR of fore wing usually 0.9-1.2 times as long as vein r *B. hebetor*
 - Antenna of female with 15-18 segments; setae of head rather adpressed, mostly not above level of upper level of posterior ocelli; vein 3-SR of fore wing 1.2-1.8 times as long as vein r *B. brevicornis*
 - 4- Hind coxa enlarged (Fig. 3E) **5**
 - Hind coxa normal **8**
 - 5- Ovipositor longer than gaster (Figs 2D, 3E); gastral tergites not pitted, slightly reticulate **6 (Torymidae)**

- Ovipositor shorter than gaster (Fig. 2E); gastral tergites coarsely pitted (Fig. 2E)..... **7 (Ormyridae)**
- 6- Occipital carina visible in dorsal view and finely raised *Adontomerus crassipes*
- Occipital carina absent *Microdontomerus annulatus*
- 7- Gaster without longitudinal carina dorsally; antennal anelli 1-segmented *Ormyrus graciosus*
- Gaster with dorso-central carina (Fig. 2E); antennal anelli 2-segmented *Ormyrus orientalis*
- 8- Antennal funicle at most 4-segmented (Fig. 1D); tarsi 4-segmented **9 (Eulophidae)**
- Antennal funicle with more than 4 segments (Figs 2F, 2B); tarsi 5-segmented (as Fig. 3E) **10**
- 9- Pronotum short; marginal vein not enlarged
..... *Aprostocetus* sp.
- Pronotum long and campanulate; marginal vein enlarged *Pronotalia carlinarum*
- 10- Body black (Fig. 2F); head and mesosoma coarsely sculptured; pronotum shoulder-like and long (Fig. 3A); funicle 5-segmented (Fig. 3B) **11 (Eurytomidae)**
- Body with metallic reflections (blue and green) (Fig. 2C), with fine sculpture; pronotum short and transverse; funicle with more than 5 segments **12 (Pteromalidae)**
- 11- Fore wing with dark patch below marginal vein (Fig. 3C); hind tibiae with several dorsal bristles (Fig. 3D)
..... *Sycophila submutica*
- Fore wing without any patch below marginal vein (Fig. 1G); hind tibiae without dorsal bristles
..... *Eurytoma acroptilae*
- 12- Scutellum with sublateral grooves dorsally; axillae enlarged and advanced; stigmal vein short, marginal vein normal (Fig. 1H) *Colotrechnus viridis*
- Scutellum without sublateral grooves; axillae normal; stigmal vein normal, marginal vein relatively thickened
..... *Pachyneuron muscarum*

Family Braconidae (Figs 1E, 2A)

Three species of the genus *Bracon* were reared from different localities in Iran (Table 1). Al-Ali *et al.* (1977)

reported larval parasitism by an unknown species of *Bracon* on safflower fruit flies in the central region of Iraq.

1-*Bracon hebetor* Say, 1857

Bracon hebetor was reported from Isfahan province as a natural enemy of fruit flies on safflower (Bagheri and Nematollahi, 2006). It is a common ectoparasitoid reported on 72 host species (Yu *et al.* 2005). But no fruit fly host is known for this species, so the Iranian record may be incorrect identification of the host. The first report of this species from Iran dates back to 1973 as a parasitoid of Indian meal moth, *Plodia interpunctella* (Hubner) (Lep.: Pyralidae) (Bagheri-Zonuz, 1973). *Bracon hebetor* is widely distributed in the Australasian, Palearctic, Ethiopian, Nearctic, Neotropical, Oriental and Oceanic regions (Yu *et al.* 2005).

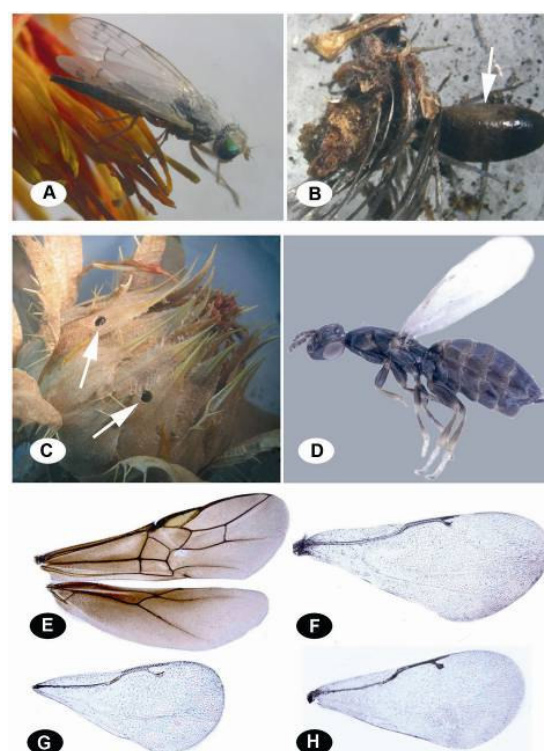


Figure 1. A- Adult female *Acanthiophilus helianthi*; B- Full developed pupa of *A. helianthi*; C- Safflower capitulum with parasitoid emergence openings; D- *Pronotalia carlinarum*, female; E- *Bracon luteator* fore and hind wings; F- *Microdontomerus annulatus* fore wing; G- *Eurytoma acroptilae* fore wing; H) *Colotrechnus viridis* fore wing.

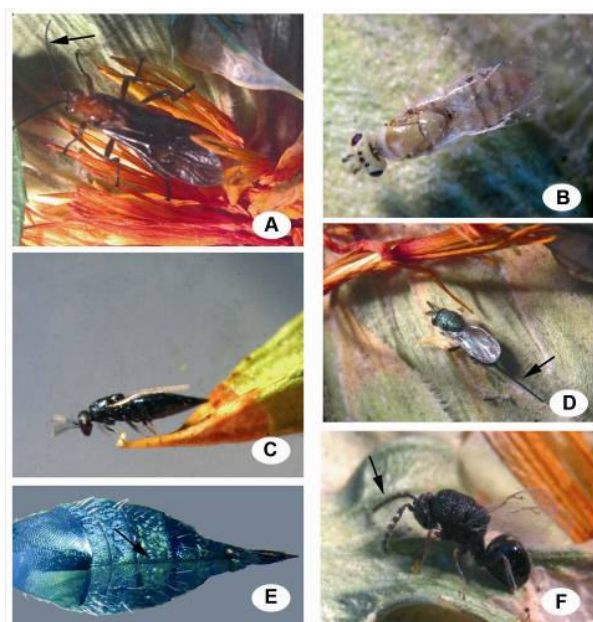


Figure 2. A- *Bracon* sp., male; B- *Aprostocetus* sp., female; C- *Colotrechnus viridis*, female; D- *Microdontomerus annulatus*, female; E- *Ormyrus orientalis*, female gaster in dorsal view; F- *Eurytoma acroptilae*, male

2- *Bracon brevicornis* (Wesmael, 1838)

Material examined: East-Azarbaijan province, Khosroshahr, safflower field, N 37°58'28" & E 46°02'55", 1346 m, 1.vii.2010, 2♀♀ and 1♂, H. Lotfalizadeh; **Ilam province**, Dareh-Shahr, vi.2003, ex Tephritidae on *Carthamus tinctorius*, 3♀♀ and 3♂♂, B. Gharali.

Note. It occurs from India to Western Europe and from Africa to Caucasus and northern Europe (Yu *et al.* 2005). It was introduced to Canada and U.S.A. as a part of classical biocontrol program against exotic pests (Yu *et al.* 2005). Gharali (2004a) has reported this species from Iran on safflower fruit flies: *A. helianthi*, *C. carthami*, *T. luteola* and *U. mauritanica*.

3- *Bracon luteator* Spinola, 1808

Material examined: East-Azarbaijan province, Khosroshahr, 1.vii.2010, safflower experimental field, N 37°58'28" & E 46°02'55", 1346 m, 7♀♀ and 46♂♂, H. Lotfalizadeh; **Chaharmahal-e-Bakhtiari province**, Gachsaran, summer.2009, N 30°20' E 50°5', 710m, 2♀♀, K. Saeidi; **Ilam province**, Darehshahr, vi.2003, ex Tephritidae

on *Carthamus tinctorius*, 2♀♀ and 3♂♂, B. Gharali.

Note. This species was reported on fruit flies *Metzneria aestivella*, *Metzneria lappella* and *Urophora solstitialis* (Yu *et al.* 2005) but its association with safflower fruit flies is a new finding.

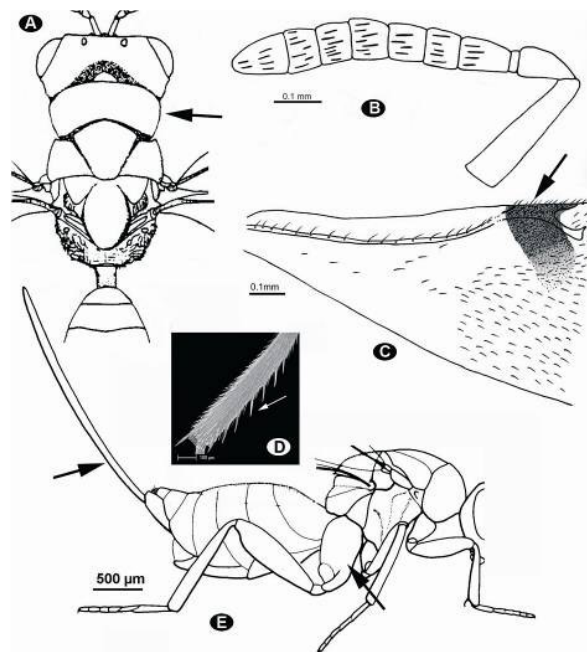


Figure 3. A- Eurytomidae, thorax in dorsal view; B- *Sycophila submutica*, female antenna; C- *S. submutica*, fore wing venation; D- *S. submutica*, hind tibia; E- Torymidae, female in lateral view

Family Eulophidae (Figs 1D, 2B)

4- *Aprostocetus* sp.

Material examined: East-Azarbaijan province, Khosroshahr, safflower's experimental field, N 37°58'28" & E 46°02'55", 1346 m, 17.vii.2010, 5♀♀, H. Lotfalizadeh.

This genus has been reported as parasitoid on different species of fruit flies (Noyes, 2012) but not on safflower fruit flies.

5- *Pronotalia carlinarum* (Szelényi and Erdős, 1951)

Material examined: Ilam province, Shirvan-Chardaval, vi.2003, on *Carthamus oxycantus*, *C. lanatus* and *C. tinctorius*, 10♀♀ and 9♂♂, B. Gharali; **Chaharmahal-e-Bakhtiari province**, Gachsaran, summer.2009, N 30°20' E

50°5', 710m, 11♀♀ and 5♂♂, K. Saeidi; **East-Azarbaijan province**, Khosroshahr, 1.vii.2010, ex Tephritidae on *Carthamus tinctorius* in safflower experimental field, N 37°58'28" & E 46°02'55", 1346 m, 15♀♀ and 6♂♂, H. Lotfalizadeh.

Note. *Pronotalia carlinarum* belongs to the subfamily Tetrastichinae. It is widely distributed in the Holarctic region from Caucasus to USA as a gregarious parasitoid (Noyes, 2012). An unknown species of *Pronotalia* was reported on *A. helianthi* in Egyptian Western Desert (Hegazi and Moursi, 1983). This is the first record of safflower fruit flies as host of *P. carlinarum*. Doğanlar (1993) presented a key to five species of *Pronotalia* in Turkey.

Family Eurytomidae (Figs 1G, 2F, 3A-D)

Two eurytomids species belong two different genera were reared on safflower seed pests: *Eurytoma* and *Sycophila*. The first genus is a specious group with different species groups (Lotfalizadeh *et al.* 2007). These two species are parasitoid of cynipid gall wasps on safflower.

6- *Eurytoma acroptilae* Zerova, 1986

Material examined: **Ilam province**, Shirvan-Chardavol, vi.2003, on *Carthamus tinctorius*, 3 ♀♀, B. Gharali; **East-Azarbaijan province**, Khosroshahr, safflower's experimental field, 1.vii.2010, ex safflower gall wasp, N 37°58'28" & E 46°02'55", 1346 m, 2♀♀ and 11♂♂, H. Lotfalizadeh; **Chaharmahal-e-Bakhtiari province**, Gachsaran, summer 2009, ex Tephritidae, N 30°20' E 50°5', 710m, 12 ♀♀ and 9 ♂♂, K. Saeidi.

Note. Our studied specimens were obtained from safflower gall wasp (East-Azarbaijan and Ilam provinces) but we examined specimens reared from safflower fruit flies (Chaharmahal-e-Bakhtiari province) that the later need to be confirmed. *Eurytoma acroptilae* was known as parasitoid of cynipid wasp genera *Aulacidea* and *Isocolus* (Zerova, 1986). Gharali and Zerova (2004) reported it as a parasitoid of safflower gall wasp in Iran. It was found abundantly in the studied areas and commonly observed in safflower's experimental field in East-Azarbaijan province. Zerova (1986) recorded this species from Tajikistan, Ukraine and USSR.

7- *Sycophila submutica* (Thomson, 1876)

Material examined: **Ilam province**, Dehloran, 30.iii.2002, ex *Isocolus tinctorius* on *Carthamus tinctorius*, 3 ♀♀, B. Gharali.

Note. This species has been recently reported from Iran (Lotfalizadeh and Gharali, 2005). *Sycophila submutica* is the main parasitoid of cynipid gall-makers wasps associated with Asteraceae and *Quercus* spp. and widely distributed in the Palaearctic region (from Central Asia to Europe). The rate of parasitism on gall wasp larvae doesn't exceed 1% in the south of Ilam province (Melika and Gharali, 2006). The genera *Aulacidea*, *Isocolus*, *Liposthenes* and *Phanacis* (Hym.: Cynipidae) are known as hosts of this species (Nieves-Aldrey, 2001; Zerova, 1995).

Family Ormyridae (Fig. 2E)

Two species of the genus *Ormyrus* Westwood were reared on safflower capitula.

8- *Ormyrus gratusus* (Förster, 1860)

Material examined: **Ilam province**, Shirvan-Chardavol and Dehloran, ex *Isocolus tinctorius* on safflower *Carthamus oxycantha* M.B, 30.iii.2002, 4♀♀ and 9♂♂, B. Gharali.

Note. *Ormyrus gratusus* was reared on safflower cynipid wasp *I. tinctorius* (Hym.: Cynipidae) from Ilam Province and this biological association was recently recorded as a new record from Iran (Lotfalizadeh *et al.* 2012). Gharali and Zerova (2004) reported it as the most important parasitoid responsible for reducing safflower gall wasp in Iran and a widely distributed member of the parasitoid complexes associated with safflower gall wasp. They believe *O. gratusus* has higher frequency than *Sycophila submutica* (Hym.: Eurytomidae), and *Adontomerus crassipes* (Hym.: Torymidae). *Ormyrus gratusus* associated with Cynipidae and Tephritidae in the Palaearctic region (Zerova and Seryogina, 2006; Lotfalizadeh *et al.* 2012).

9- *Ormyrus orientalis* Walker, 1871 (Fig. 2E)

Material examined: **Isfahan province**, Isfahan, ex *Acanthiophilus helianthi* on safflower *Carthamus oxycantha* M.B, summer.2008, 2♀♀, M.R. Sabzalian; **East-Azarbaijan**

province, Khosroshahr, 15.vii.2010, safflower's experimental field, N 37°58'28" & E 46°02'55", 1346 m, 2♀♀ and 6♂♂, H. Lotfalizadeh; **Chaharmahal-e-Bakhtiari province**, Gachsaran, summer.2009, N 30°20' E 50°5', 710m, 1♂, K. Saeidi.

Note. This common species is a parasitoid of safflower fruit flies in the central part of Iran (Isfahan Province) and was reported commonly in East-Azerbaijan Province (northwest Iran) (Lotfalizadeh *et al.* 2012). A wide host range is reported for this species. It is associated with some hymenopterous families (Cynipidae and Eurytomidae) and also gall-inducing fruit flies (Tephritidae) on Asteraceae. This species is a common species of Old World (Noyes 2012). *Ormyrus orientalis* has been reported from Iran without biological data (OILB, 1971; Bouček, 1977).

All species of *Ormyrus* are solitary and larval ectoparasitoids (occasionally secondary parasitoids) of gall-maker insects *e.g.* Cynipidae, Cecidomyiidae, Tephritidae and Agromyzidae in the Palaearctic region (Askew, 1994; Zerova and Seryogina, 1999, 2006; Nazemi-Rafie *et al.* 2007). The Palaearctic species of the genus were keyed by Zerova and Seryogina (2006). Recently, 11 species of the genus *Ormyrus* are listed from Iran (Lotfalizadeh *et al.* 2012).

Family Pteromalidae (Figs 1H, 2C)

In this research, three species of pteromalids were reared that two are new records for Iran. Based on the recently published checklist (Lotfalizadeh and Gharali, 2008), this family include 78 species in Iran.

10- *Colotrechnus viridis* (Masi, 1921)

Material examined: **Ilam province**, Dehloran, vi.2002, ex fruit flies (Dip.: Tephritidae) on safflower (*Carthamus tinctorius*), 2♀♀ and 1♂, B. Gharali; **East-Azerbaijan province**, Khosroshahr, 15.vii.2010, safflower's experimental field, N 37°58'28" & E 46°02'55", 1346 m, 5♀♀, H. Lotfalizadeh; **Chaharmahal-e-Bakhtiari province**, Gachsaran, summer.2009, N 30°20' E 50°5', 710m, 4♀♀, K. Saeidi.

Note. This West-Palaearctic species, belonging to Colotrechninae, has been reported from Iran as a parasitoid of safflower fruit flies (Lotfalizadeh and Gharali, 2008). It was

reared from the weevil *Microlarinus lypriformis* (Col.: Cuculionidae) in Turkey (Öncüer, 1991).

11- *Pachyneuron muscarum* (Linnaeus, 1758)

Note. Bagheri and Nematollahi (2006) reported it under the name of *Pachyneuron concolor* (Förster) as a hyperparasitoid associated with safflower fruit flies in Isfahan Province. This species is frequently reported from Iran as a hyperparasitoid of different groups of insects such as Coccidae, Psyllidae (Hemiptera) and Chrysopidae (Neuroptera) (Lotfalizadeh and Gharali, 2008). Considering that the hemipterous insects and lacewings are host of this species, therefore, it may be Bagheri and Nematollahi (2006) reared *P. muscarum* from this group on safflower or it is an incorrect identification.

12- *Pteromalus albipennis* Walker, 1835

Material examined: **East-Azerbaijan province**, Khosroshahr, 8.vii.2010, ex Tephritidae in safflower experimental field, N 37°58'28" & E 46°02'55", 1346 m, 8♀♀ and 5♂♂, H. Lotfalizadeh; **Chaharmahal-e-Bakhtiari province**, Gachsaran, summer.2009, N 30°20' E 50°5', 710m, ex Tephritidae, 3♀♀ and 2♂♂, K. Saeidi.

Note. It is widely distributed in Europe and was reported from Turkey and Kazakhstan as a parasitoid of several genera of fruit flies (Dip.: Tephritidae) on plants in the families Asteraceae, Brassicaceae, Poaceae and Santalaceae (Noyes, 2012) but is new for Iran. This is a new host record for this species.

Family Torymidae (Figs 1F, 2D, 3E)

13- *Adontomerus crassipes* (BOUČEK, 1982)

Material examined: **Ilam province**, Shirvan-Chardaval, 3.vi.2002, ex *Isocolus tinctorius* (Hym.: Cynipidae), 1♀, B. Gharali.

This species is parasitoid of cynipid wasps of the genus *Andricus* and *Isocolus* in Algeria and Spain (Noyes, 2012) but its association with *Isocolus tinctorius* has been reported from Iran by Lotfalizadeh and Gharali (2005).

14- *Microdontomerus annulatus* (Spinola, 1808) (Fig. 2D)

Material examined: **Ilam province**, Dehloran, 3.vi.2003, B. Gharali, 7♀♀ and 2♂♂. Dareh-Shahr, 8.vi.2003, 5♀♀ and 3♂♂, B. Gharali,; **Isfahan province**, Isfahan, ex *Acanthiophilus helianthi* on safflower *Carthamus tinctorius* and *C. lanatus*, summer.2008, 2♀♀ and 1♂, M.R. Sabzalian; **East-Azarbaijan province**, Khosroshahr, 1.vii.2010, ex Tephritidae in safflower experimental field, N 37°58'28" & E 46°02'55", 1346m, 17♀♀ and 25♂♂, H. Lotfalizadeh; **Chaharmahal-e-Bakhtiari province**, Gachsaran, ex Tephritidae, summer.2009, N 30°20' E 50°5', 710m, 20♀♀ and 29♂♂, K. Saeidi.

Note. Lotfalizadeh and Gharali (2005) have reported this species on three species of safflower fruit flies (*A. helianthi*, *Chaetorellia carthami* and *Terellia serratulae*). *Microdontomerus annulatus* is known from Egypt as a parasitoid of *A. helianthi* (Hegazi & Moursi, 1983) and a parasitoid of *T. serratulae* (Baloch and Khan, 1973). This association with *C. carthami* is a new host record. This

species was reared on Tephritidae (Diptera), Tortricidae (Lepidoptera) and Cynipidae (Hymenoptera) associated with the family Asteraceae (Noyes, 2012). Our laboratory rearing confirmed their association with Tephritidae but its association with Cynipidae may be a dubious record that probably resulted from the presence of fruit flies (Tephritidae) and safflower gall wasp (Cynipidae) at the same time on the host plant. This species occurs in Europe, Middle East and North Africa (Noyes, 2012).

The family Torymidae includes 41 known species in the Iranian fauna (Fallahzadeh *et al.* 2009). Lotfalizadeh and Gharali (2005) listed two species *Adontomerus crassipes* (Bouček) and *Microdontomerus annulatus* (Spinola) obtained from safflower fields in Iran. *Torymoides kiesenwetteri* (Mayr) is another torymid species associated with safflower fruit flies (especially *A. helianthi*) in Europe, India and Northern Africa (Grissell, 1995).

Table 1- Reared parasitoids associated with safflower capitulum pests in Iran

Parasitoids species	Host	Distribution in Iran	Date	Studied specimens
Braconidae				
<i>Bracon hebetor</i> Say	Safflower fruit flies (Tephritidae)	Isfahan	--	Not examined (reported by Bagheri & Nematollahi, 2006)
<i>Bracon brevicornis</i> (Wesmael)	Safflower fruit flies	East-Azarbaijan Ilam	1.vii.2010 vi.2003	2♀♀ & 1♂ 3♀♀ & 3♂♂
<i>Bracon luteator</i> Spinola	Safflower fruit flies	East-Azarbaijan Chaharmahal-e-Bakhtiari Ilam	1.vii.2010 summer.2009 vi.2003	7♀♀ & 46♂♂ 2♀♀ 2♀♀ & 3♂♂
Eulophidae				
<i>Aprostocetus</i> sp.	Safflower fruit flies	East-Azarbaijan	17.vii.2010	5♀♀
<i>Pronotalia carlinarum</i> (Szelényi and Erdős)	Safflower fruit flies	East-Azarbaijan Chaharmahal-e-Bakhtiari Ilam	1.vii.2010 summer.2009 vi.2003	15♀♀ & 6♂♂ 11♀♀ & 5♂♂ 10♀♀ & 9♂♂
Eurytomidae				
<i>Eurytoma acroptilae</i> Zerova	Safflower fruit flies ?, <i>Isocolus tinctorius</i> Melika & Gharali (Cynipidae)	East-Azarbaijan Chaharmahal-e-Bakhtiari Ilam	1.vii.2010 summer.2009 vi.2003	2♀♀ & 11♂♂ 12♀♀ & 9♂♂ 3♀♀
<i>Sycophila submutica</i> (Thomson)	<i>I. tinctorius</i> (Cynipidae)	Ilam	30.iii.2002	3♀♀
Ormyridae				
<i>Ormyrus gratosus</i> (Förster)	<i>I. tinctorius</i> (Cynipidae)	Ilam	30.iii.2002	4♀♀ & 9♂♂
<i>Ormyrus orientalis</i> Walker	Safflower fruit flies	East-Azarbaijan Chaharmahal-e-Bakhtiari Isfahan	15.vii.2010 summer.2009 summer.2008 --	2♀♀ and 6♂♂ 1♂ 2♀♀ --

Table 1 continued- Reared parasitoids associated with safflower capitulum pests in Iran

Parasitoids species	Host	Distribution in Iran	Date	Studied specimens
Pteromalidae				
<i>Colotrechnus viridis</i> (Masi)	Safflower fruit flies	East-Azarbaijan Chaharmahal-e-Bakhtiari Ilam	15.vii.2010 summer.2009 vi.2002	5 ♀♀ 4 ♀♀ 2 ♀♀ & 1 ♂
<i>Pachyneuron muscarum</i> (Linnaeus)	Hyperparasitoid of Safflower fruit flies	Isfahan	--	Not examined (reported by Bagheri & Nematollahi, 2006)
<i>Pteromalus albipennis</i> Walker	Safflower fruit flies	East-Azarbaijan Chaharmahal-e-Bakhtiari	8.vii.2010 summer.2009	8 ♀♀ & 5 ♂♂ 3 ♀♀ & 2 ♂♂
Torymidae				
<i>Adontomerus crassipes</i> (Bouček)	<i>I. tinctorius</i> (Cynipidae)	Ilam	3.vi.2003	1 ♂
<i>Microdontomerus annulatus</i> (Spinola)	Safflower fruit flies, <i>I. tinctorius</i> (Cynipidae)?	East-Azarbaijan	1.vii.2010	17 ♀♀ & 25 ♂♂
		Chaharmahal-e-Bakhtiari	summer.2009	20 ♀♀ & 29 ♂♂
		Isfahan	summer.2008	2 ♀♀ & 1 ♂
		Ilam	--	--
			3.vi.2003, 8.vi.2003	7 ♀♀ & 2 ♂♂, 5 ♀♀ & 3 ♂♂

In the studied area the safflower fruit fly, *A. helianthi* was a most frequently encountered species and seems to be most serious pest of safflower such as mentioned by Bagheri and Nematollahi (2006) and Saeedi (2006). However, this pest attacks by 10 parasitic wasps (Gharali and Zerova, 2004; Bagheri and Nematollahi, 2006; Saeedi, 2006) but its direct damage of safflower seeds obligate to insecticides application. Therefore, application of new generation of insecticides especially bio-insecticides could be recommendable if pest control is unavoidable.

Within the parasitic species, two parasitoids *Bracon luteator* and *Microdontomerus annulatus* were relatively most abundant species on fruit flies in Iran and *M. annulatus* is geographically more widespread species. Also *Eurytoma acroptilae* was a common parasitoid of fruit flies and gall wasp in safflower fields. While Gharali and Zerova (2004) reported *Ormyrus graciosus* the most important parasitoid of safflower gall wasp in Ilam, west of Iran.

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