

## Preliminary taxonomic study of the genus *Praon* (Hymenoptera: Braconidae: Aphidiinae) and its host associations in Iran

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### Abstract

In the current study, the information on occurrence, distribution and host aphid-plant associations for the species of *Praon* Haliday in Iran are presented. Eight species of *Praon* were found in the areas under study, which include four previously reported species, viz. *Praon absinthii* Bignell, *Praon barbatum* Mackauer, *Praon exsoletum* (Nees) and *Praon volucre* (Haliday), and four new records, *Praon orpheusi* Kavallieratos, Athanassiou & Tomanović, *Praon rosaecola* Starý, *Praon abjectum* (Haliday) and *Praon yomenae* Takada, of which *P. volucre* was the most common species. The presence of *P. yomenae* as a parasitoid of *Uroleucon* aphids, instead of *Praon dorsale* (Haliday), which does not occur in Iran, is documented. A key for identification of the *Praon* species occurring in Iran is presented.

**Key words:** Braconidae, Aphidiinae, *Praon*, host association, Iran

### چکیده

در این تحقیق، اطلاعاتی در زمینه فعالیت زمانی، پراکنش و روابط میزبانی زنبورهای پارازیتوئید جنس *Praon* در ایران ارائه می‌گردد. هشت گونه از این جنس در نواحی مورد بررسی جمع‌آوری شد که از میان آنها چهار گونه‌ی *Praon absinthii* Bignell، *Praon barbatum* Mackauer، *Praon exsoletum* (Nees) و *Praon volucre* (Haliday) قبلاً از ایران گزارش شده بودند و چهار گونه‌ی دیگر شامل *Praon orpheusi* Kavallieratos، Athanassiou & Tomanović و *Praon yomenae* Takada برای اولین بار از ایران گزارش می‌شوند. زنبور *P. volucre* شایع‌ترین گونه‌ی جمع‌آوری شده بود. وجود گونه‌ی *P. yomenae*، پارازیتوئید شته‌های جنس *Uroleucon* به جای گونه‌ی *Praon dorsale* (Haliday) مورد بحث قرار گرفته و کلیدی برای شناسایی گونه‌های جنس *Praon* در ایران ارائه شده است.

واژگان کلیدی: Braconidae، Aphidiinae، *Praon*، روابط میزبانی، ایران

### Introduction

The subfamily Aphidiinae, includes more than 55 genera and about 400 known species (Starý, 1988), among them the genus *Praon* Haliday is one of the largest genera with more than 50 described species worldwide (Kavallieratos *et al.*, 2005). The genus *Praon* includes species which spin their cocoon under the empty body of parasitized aphid. Most other aphidiines pupate inside the parasitized aphid (Starý, 1970). The species belonging to genus *Praon* have an extensive and variable host range (Mackauer, 1959; Johnson, 1987; Mescheloff & Rosen, 1988; Kavallieratos *et al.*, 2001). Many species are important parasitoids of aphids in various agro-and forest ecosystems (Starý, 1976).

Several taxonomical studies on *Praon*, as well as on its aphid-plant associations, have been carried out in North America (Johnson, 1987; Pike *et al.*, 1997); South America (Starý & Vogel, 1985; Starý, 1995); Asia (Starý & Schlinger, 1967; Takada, 1968; Paik, 1975; Starý & Ghosh, 1983; Mescheloff & Rosen, 1988) and Europe (Mackauer, 1959; Starý, 1981; Tremblay & Pennacchio, 1985; Kavallieratos & Lykouressis, 2000; Tomanović & Kavallieratos, 2001; Kavallieratos *et al.*, 2003, 2004, 2005; Tomanović *et al.*, 2003a, 2003b). Due to a great intraspecific variability, there are several taxonomic problems within the genus (Mackauer, 1959; Starý, 1966, 1971; Tremblay & Pennacchio, 1985). The morphological differences between the species are very low and, sometimes, precise identification is impossible using the regular characters. Host range, in some cases, is a useful biological feature to identify the species/species-groups.

Dolati (1994) and Zareh *et al.* (1995) recorded *P. volucre* as a parasitoid of *Diuraphis noxia* (Mordvilko) in Iran. Starý *et al.* (2000) reviewed the aphid parasitoids of Iran and listed five species of *Praon*. Data on distribution and partly on host associations for some *Praon* species of Iran have also been provided by Rakhshani *et al.* (2005, 2006). Adjacent countries of Iran, including Iraq (Starý & Kaddou, 1971), Turkey (El-Mali *et al.*, 2004), Georgia (Achvlediani, 1981) and Pakistan (Starý *et al.*, 1998), were also partially explored for aphid parasitoids.

Successful biological control programs are always depending on the correct and precise identification of the natural enemies of the target pest species. In the current study, the known and new record species of *Praon* from Iran are morphologically investigated and an identification guide to the species is presented. Furthermore, information on parasitoid-aphid-plant associations is provided.

### Materials and methods

Specimens from wild and cultivated plants bearing aphid colonies, containing both live and parasitized aphids, were collected from several provinces of Iran including Ardabil, Fars, Golestan, Guilan, Hamedan, Isfahan, Kermanshah, Khuzestan, Kordestan, Markazi, Quazvin, Sistan-Baluchestan, Tehran, and Zanjan during 2002-2005. Since the pupation of *Praon* species takes place under the parasitized aphid, the pupae are very sensitive to physical damages. Therefore, the samples were directly placed within the plastic rearing boxes and covered with mesh. Then the rearing boxes were kept in the laboratory at  $20 \pm 5$  °C for 20-25 days to allow the parasitoids to complete their development and emerge. They generally

emerged within 5-10 days, which were then transferred to 96% ethyl alcohol. Different parts of the body, such as head, mesonotum, propodeum, metasomal tergite I and the female genitalia, taken from dissected parasitoid specimens were mounted on slides. The host aphids were preserved in 75% ethyl alcohol until prepared for slide-mounting.

Aphid nomenclature follows Remaudière & Remaudière (1997). The morphological terminology used for parasitoid species is based on Starý (1976) and Kavallieratos *et al.* (2005). The studied and identified specimens were deposited in the insect collection of Department of Entomology, Tarbiat Modarres University, and some specimens, in the collection of N. G. Kavallieratos (Benaki Phytopathological Institute, Greece).

## Results

A total of eight *Praon* species from 28 aphid species occurring on 33 host plants were reared. As a result, 54 tritrophic associations were found, of which 27 associations are newly recorded. Also, three species, *Praon orpheusi* Kavallieratos, Athanassiou & Tomanović, *P. rosaecola* Starý and *P. abjectum* (Haliday) are new records for Iran. *Praon yomenae* Takada, which has been previously recorded as *P. dorsale* (Haliday), occurred in association with *Uroleucon* aphids in several occasions.

### Key to female *Praon* species of Iran

1. Flagellomere I entirely yellow .....2
- Flagellomere I dark, yellowish at base, or yellow with at least the apical third dark .....4
2. Forewing m-cu weakly developed (fig. 13); propodeum covered with few long hairs (fig. 21); tergite I with few lateral hairs (fig. 29).....*Praon exsoletum* (Nees)
- Forewing m-cu complete, but colourless throughout (figs 12, 17); propodeum covered with dense hairs (figs 20, 25); metasomal tergite I with several lateral and dorsal hairs (figs 28, 33).....3
3. Face densely pubescent (fig. 2); antennae 20-21 segmented; ovipositor sheath elongate (fig. 34).....*Praon barbatum* Mackauer
- Face sparsely pubescent (fig. 3); antennae 18-19 segmented; ovipositor sheath not elongate (fig. 37)..... *Praon yomenae* Takada
4. Lateral lobes of mesoscutum with large hairless areas (fig. 5); forewing m-cu vein colourless throughout, median vein short (fig. 11); propodeum sparsely setous (fig. 19);

- metasomal tergite I 1.35-1.4 time as long as its width at spiracles (fig. 27) .....  
 .....*Praon absinthii* Bignell
- Lateral lobes of mesoscutum pubescent or with few hairless areas (figs 4, 7, 8); forewing m-cu coloured throughout, median vein long (figs 10, 14, 15, 16); propodeum with normal or dense hairs (figs 18, 22, 23, 24); metasomal tergite I shorter than 1.3 time of its width at spiracles (figs 26, 30, 31, 32).....5
5. Forewing Rs vein effaced, point like (fig. 14); antennae 16-17 segmented; mesoscutum with lateral lobes densely pubescent (fig. 7) .....  
 .....*Praon orpheusi* Kavallieratos, Athanassiou & Tomanović
- Forewing Rs never point like and normally developed (figs 10, 15, 16); antennae 15-18 (19) segmented; mesoscutum with lateral lobes densely pubescent or with hairless areas (figs 4, 8)..... 6
6. Antennae 15-16 segmented; lateral lobes of mesoscutum with hairless areas (fig. 4); face sparsely setous (fig. 1).....*Praon abjectum* (Haliday)
- Antennae (16) 17-19 segmented; lateral lobes of mesoscutum densely pubescent (fig. 8) .....7
7. Forewing stigma 2.1-2.35 time as long as R1 (fig. 15); dorsal outline of the ovipositor sheath almost straight, ovipositor sheath rounded at apex (fig. 35); tergite I with few sparse hairs (fig. 31); antennae (15) 16-17 segmented.....*Praon rosaecola* Starý
- Forewing stigma 1.4-1.65 time as long as R1 (fig. 16); dorsal outline of the ovipositor sheath concave, ovipositor sheath lanceolate (fig. 36); tergite I with short dense dorsal hairs (fig. 32); antennae 17-18 (19) segmented .....*Praon volucre* (Haliday)

#### Tritrophic associations

Parasitoid-aphid-plant relationships are summarized in the list below. Parasitoid species are listed alphabetically.

#### *Praon abjectum*

(Figs 1, 4, 10, 18, 26)

Host record: *Brachycaudus cardui* (L.) on *Prunus padus*, 21 April 2002, Tehran, Peykanschahr.

***Praon absinthii***

(Figs 5, 11, 19, 27)

Host records: *Macrosiphoniella oblonga* (Mordvilko) on *Artemisia annua*, 11 May 2005, Zanjan, Kiashahr; *Macrosiphoniella sanborni* (Gillette) on *Chrysanthemum morifolium*, 11 May 2005, Tehran.

***Praon barbatum***

(Figs 2, 6, 12, 20, 34)

Host record: *Acyrtosiphon pisum* (Harris) on *Vicia villosa*, 14 May 2005, Saveh; on *Vicia pannonica*, 13 July 2004, Tehran, Peykanschahr.

***Praon exsoletum***

(Figs. 13, 21, 29)

Host records: *Therioaphis trifolii maculata* (Buckton) on *Medicago sativa*, 25 April 2002, Karaj; 16 May 2002, Varamin; 8 February 2003, Rigzar, Zahedan; 11 April 2003 and 7 April 2004, Zahedan; 6 April 2004, Zabol; 29 April 2004, Taftan; 1 August 2004, Ardabil; 3 August 2004, Pars-Abad; 10 September 2004 Sanandaj; 11 September 2004, Marivan; 13 September 2004, Biston; 14 September 2004, Hamadan; 14 September 2004, Saveh.

***Praon orpheusi***

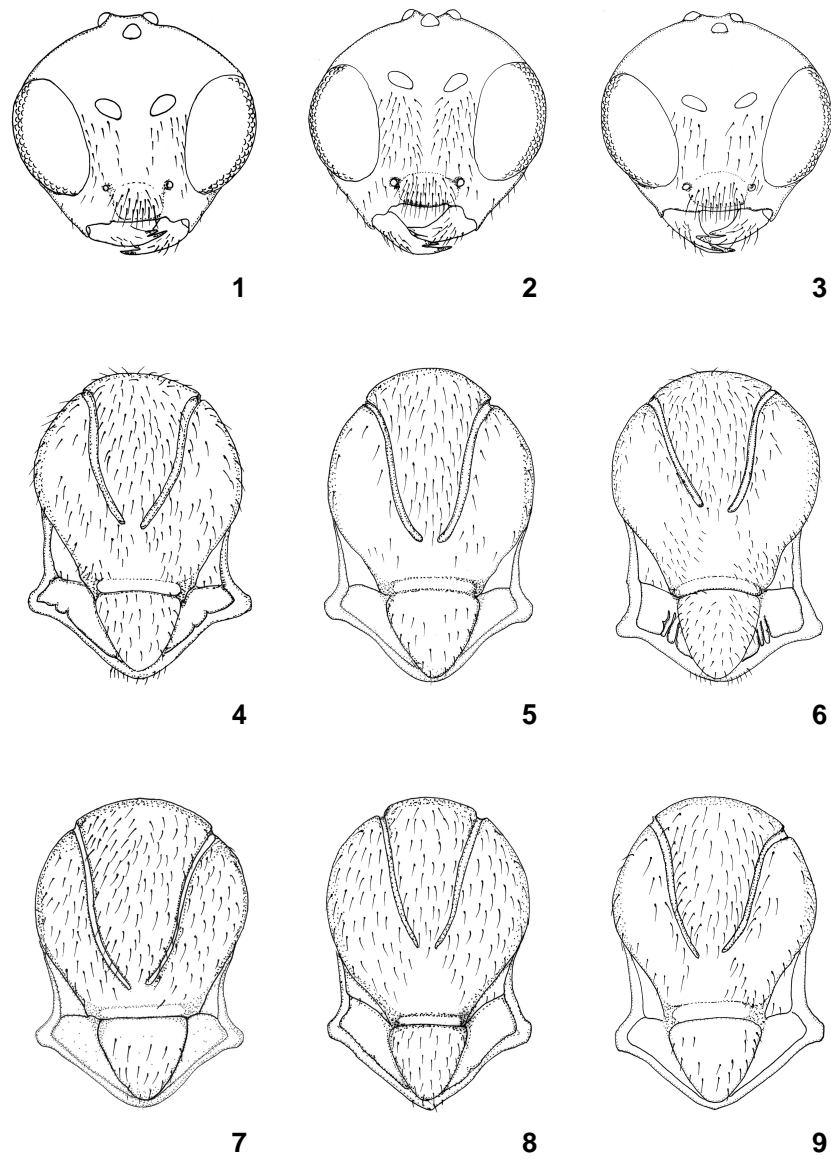
(Figs 7, 14, 22, 30)

Host record: *Hyperomyzus lactucae* (L.) on *Lactuca oleracea*, 31 June 2004, Evin, Tehran.

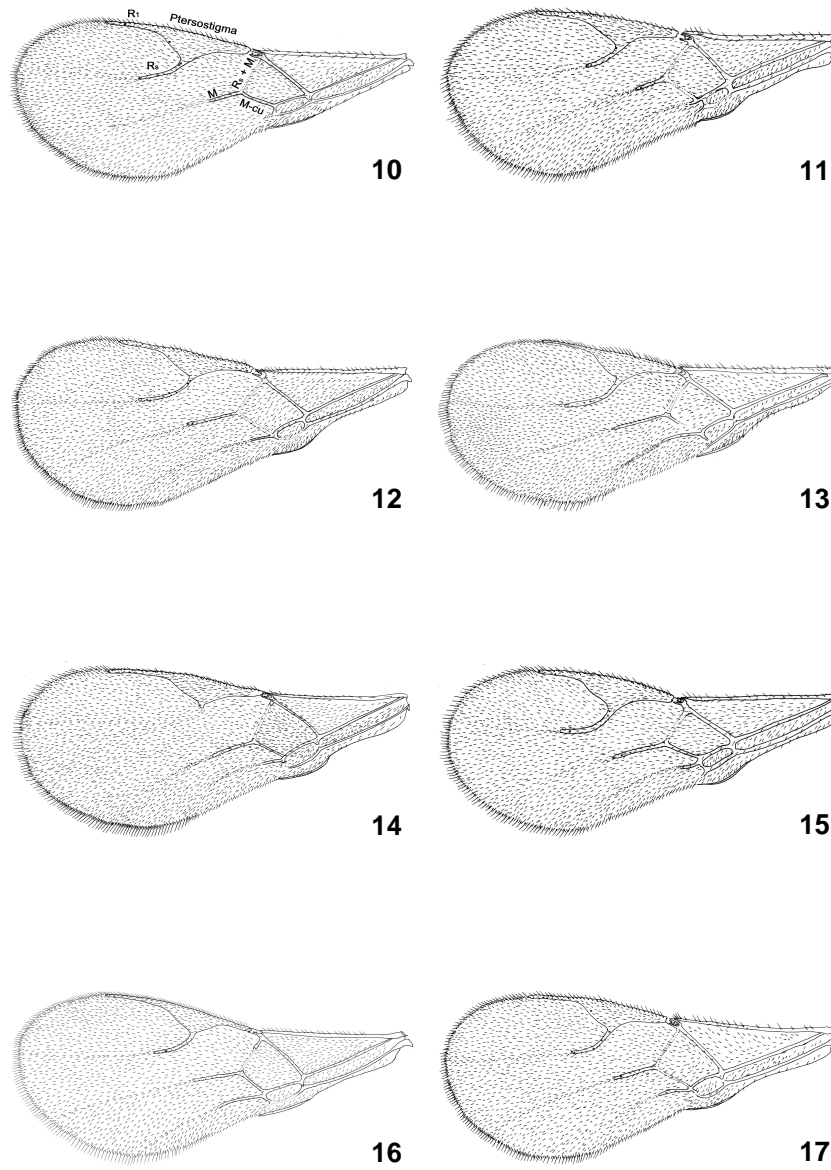
***Praon rosaecola***

(Figs 8, 15, 23, 31)

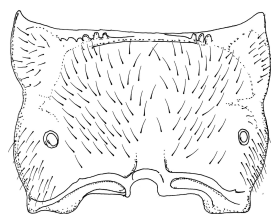
Host record: *Macrosiphum rosae* (L.) on *Rosa* sp., 26 Oct. 2004, Chalous Road, Shahrestanak; on *Rosa* sp., 27 October 2004, Aghasht.



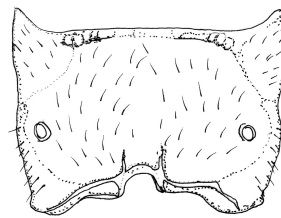
**Figures 1-9.** 1-3, head: 1. *P. abjectum*, 2. *P. barbatum*, 3. *P. yomenae*; 4-9, mesoscutum: 4. *P. abjectum*, 5. *P. absinthii*, 6. *P. barbatum*, 7. *P. orpheusi*, 8. *P. rosaecola*, 9. *P. yomenae*.



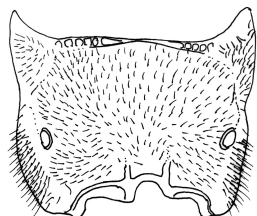
**Figures 10-17.** Forewing: 10. *P. abjectum*, 11. *P. absinthii*, 12. *P. barbatum*, 13. *P. exsoletum*, 14. *P. orpheusi*, 15. *P. rosaecola*, 16. *P. volucre*, 17. *P. yomenae*.



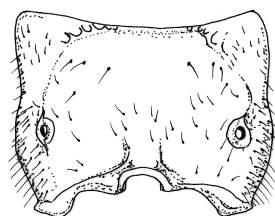
18



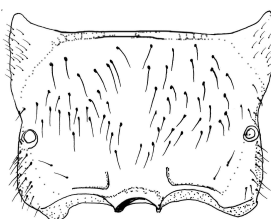
19



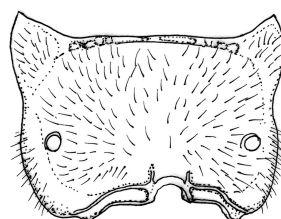
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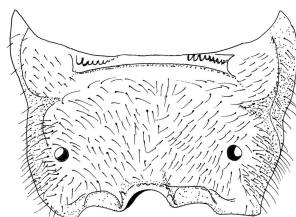
21



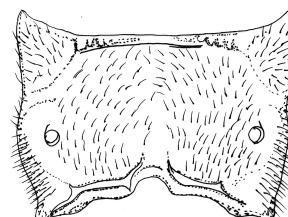
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23



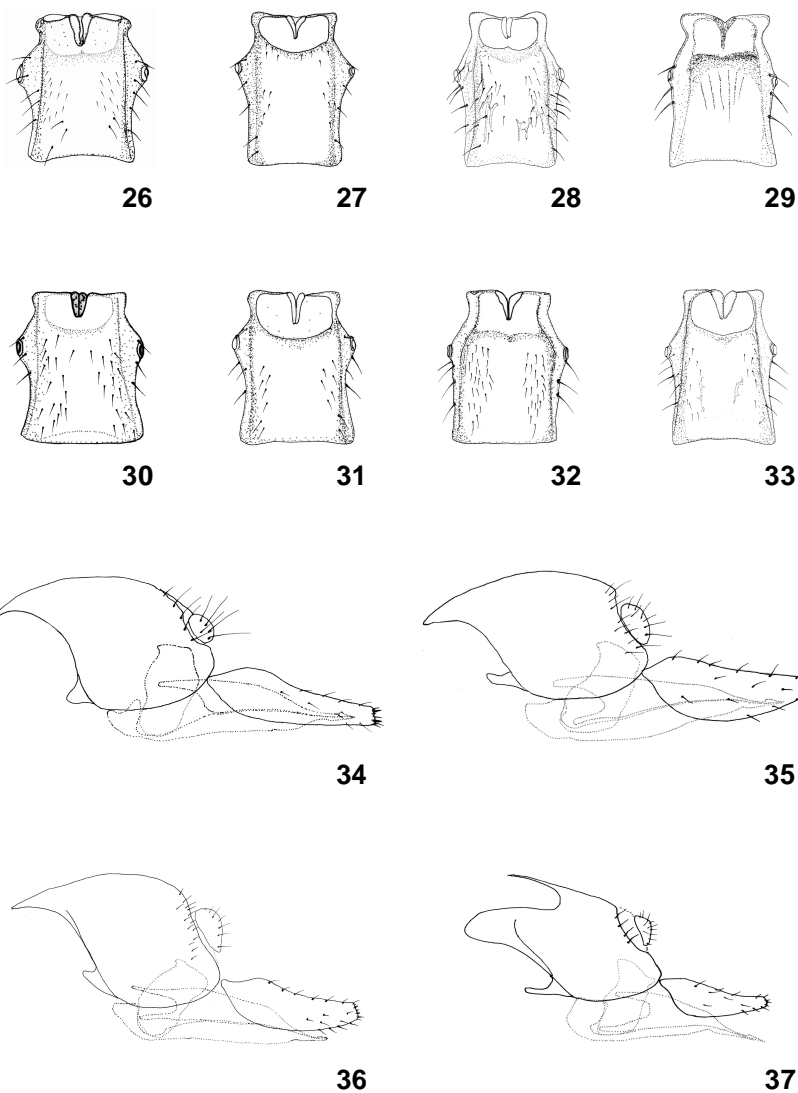
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25

**Figures 18-25.** Propodeum: 18. *P. abjectum*, 19. *P. absinthii*, 20. *P. barbatum*, 21. *P. exsoletum*, 22. *P. orpheusi*, 23. *P. rosaecola*, 24. *P. volucre*, 25. *P. yomenae*.





**Figures 26-37.** 26-33, metasomal tergite I: 26. *P. abjectum*, 27. *P. absinthii*, 28. *P. barbatum*, 29. *P. exsoletum*, 30. *P. orpheusi*, 31. *P. rosaecola*, 32. *P. volucre*, 33. *P. yomenae*; 34-37, female genitalia: 34. *P. barbatum*, 35. *P. rosaecola*, 36. *P. volucre*, 37. *P. yomenae*.

***Praon volucre***

(Figs 16, 24, 32, 36)

Host records: *Acyrtosiphon lactucae* (Passerini) on *Lactuca serriola*, 18 May 2003, Tehran, Peykanschahr; *A. pisum* on *V. villosa*, 14 May 2005, Saveh; on *M. sativa*, 20 April 2003, Qazvin, Abhar; 29 May 2003, Taftan, Khash; 23 September 2004, Saveh; *Aphis craccivora* Koch on *M. sativa*, 16 May 2002, Varamin; 16 April 2003 and 5 April 2004, Zabol; on *Robinia pseudoacacia*, 11 April 2003, Zahedan; 27 June 2003, Shahriar; *Aphis fabae circiicanthoides* Scopoli on *Cirsium arvensis*, 27 June 2003, Shahriar; *Aphis fabae solenella* Theobald on *Solanum lycopersicum*, 5 November 2004, Aghasht; on *Solanum nigrum*, 7 September 2004, Sahneh; *Aphis fabae* Scopoli on *Chenopodium album*, 10 November 2004, Tehran, Peykanschahr; on *Vicia fabae*, 5 March 2005, Dezful; *Brachycaudus amygdalinus* (Schouteden) on *Amygdalus arabica*, 23 April 2003, Khash, Taftan; *Brachycaudus helichrysi* (Kaltenbach), on *Calendula officinalis*, 29 October 2004, Isfahan; *D. noxia* on *Triticum aestivum*, 24 April 2005, Salafchegan; 27 April 2005, Shiraz, Kharameh; *Hyalopterus amygdali* (Blanchard) on *Prunus amygdalinus*, 27 June 2003, Shahriar; *Hyalopterusu pruni* (Geoffrey) on *P. padus*, 6 July 2002, Karaj; on *Prunus armeniaca*, 18 May 2003, Tehran, Peykanschahr; on *Prunus persicae*, 20 June 2003, Karaj; *B. cardui* on *P. persicae*, 21 April 2002 and 23 May 2003, Peykanschahr; on *Prunus* sp., 21 April 2002, Tehran; *H. lactucae* on *L. oleracea*, 25 April 2002, Meshkindasht; on *L. serriola*, 14 June 2003, Peykanschahr; *M. rosae* on *Rosa hybrida*, 19 November 2002, Peykanschahr; on *Rosa canina*, 20 June 2003, Shahrestanak; *Myzus persicae* (Sulzer) on *Caryophila* sp., 18 May 2003, Tehran, Peykanschahr; on *Nicotiana tabacum*, 5 September 2004, Marivan; on *Capsicum annum*, 2 November 2003, Isfahan; *Schizaphis graminum* (Rondani) on *Bromus tectorum*, 12 July 2004, Tehran, Peykanschahr; on *T. aestivum*, 10 April 2004 Isfahan; 10 November 2004, Tehran; 7 March 2005, Ramhormoz; 27 April 2005, Shiraz, Kharameh; 30 June 2005, Meimeh; *Sitobion avenae* (Fabricius) on *T. aestivum*, 14 November 2004, Tehran, Peykanschahr; 28 April 2005, Abadeh; 15 May 2005, Saveh; *Rhopalosiphum maidis* Fitch on *Zea mays*, 15 May 2005, Hamadan, Nobaran; 9 June 2005, Gorgan; *Rhopalosiphum padi* (L.) on *T. aestivum*, 10 April 2004, Isfahan; 25 April 2005, Qom; 30 June 2005, Meimeh; *Phorodon humuli* (Schrank) on *P. persica*, 27 April 2003, Tehran, Peykanschahr; *Uroleucon* sp. on an unidentified host plant, 27 June 2002, Rodehen; *Uroleucon cichori* (Koch) on *Cichorium intybus*, 22 April 2004, Tehran, Peykanschahr; on *L. oleracea*, 27 October 2004, Karaj; *Uroleucon compositae* (Theobald) on *Carthamus tinctorius*, 7 November 2004,

Isfahan; *Uroleucon jaceae* (L.) on *L. oleracea*, 9 May 2005, Karaj; *Uroleucon sonchi* (L.) on *Sonchus arvensis*, 25 April 2002, Karaj; on *L. serriola*, 14 June 2003, Tehran, Peykanshahr; on *Sonchus asper*, 17 September 2004, Tehran, Peykanshahr.

#### ***Praon yomenae***

(Figs 3, 9, 17, 25, 33, 37)

Host records: *U. sonchi* on *S. asper*, 20 May 2005, Karaj; *Uroleucon* sp. on an unidentified plant, 27 June 2002, Rodehen; *U. jaceae* on *Centaurea depressa*, 8 May 2004, Isfahan; on *Acroptilon repens*, 17 April 2004, Isfahan; *Uroleucon chondrillae* (Nevsky) on *Chondrillae juncea*, 4 October 2002 and 16 April 2005; Tehran, Peykanshahr; 16 May 2005 Zanjan, Zarin-Abad; 18 May 2005, Karaj; *U. compositae* on *C. tinctorius*, 2 November 2003, Isfahan.

#### **Discussion**

*P. volucre* was the most frequent species within several associations. It is a broad oligophagous, being the best adapted species (see also Starý, 1976; Kavallieratos *et al.*, 2003, 2004.). It has been recorded from a limited host-rang from Iran (Starý *et al.*, 2000; Rakhshani *et al.*, 2005, 2006), and several new associations are introduced in the present account. *P. absinthii*, which has been recorded as a parasitoid of *Macrosiphoniella absinthii* (Starý *et al.*, 2000), was a rare species. It seems that *P. absinthii* has a restricted host range to the species of *Macrosiphoniella*, as also recorded in other studies (Starý, 1976; Kavallieratos *et al.*, 2004, 2005).

*P. abjectum*, which is newly reported from Iran, was a rare species and only found in association with *B. cardui* on *P. padus*. This parasitoid is distributed in Iraq (Starý & Kaddou, 1971), but not in Pakistan (Starý *et al.*, 1998), Turkey (El-Mali *et al.*, 2004) and Georgia (Achvlediani, 1981). In Europe, some species of *Aphis*, *Brachycaudus*, *Liosomaphis*, *Longicaudus* and *Rhopalosiphum* have been recorded as hosts of *P. abjectum* (Starý, 1976; Kavallieratos *et al.*, 2005), however, based on some records it is a specialized parasitoid of *Aphis* species (Starý & Kaddou, 1971).

*P. orpheusi*, which is also newly recorded from Iran, was initially found as a parasitoid of *M. rosae* in Greece and Bulgaria (Kavallieratos *et al.*, 2003). Here, the activity of the parasitoid on another host aphid, *H. lactucae*, was coincident with *P. volucre*. The former parasitoid, *P. orpheusi*, is also a rare species and we found it only in one occasion. The aphid,

*M. rosae*, was found to be frequently attacked by *P. volucre*, however, it was also parasitized by *P. rosaecola* in a restricted area. It is quite likely that *P. rosaecola*, which is firstly recorded from Asia, to be a specific parasitoid of *M. rosae*.

Starý *et al.* (2000) was previously recorded *P. barbatum* as a parasitoid of *A. pisum* on *M. sativa* in Iran. This association has also been recorded in several countries (Starý, 2006; Kavallieratos *et al.*, 2004), but in the current study, it was only found to parasitize *A. pisum* on wild *Vicia* species (see above).

*P. yomenae* is the same species that has previously been recorded as *P. dorsale* as a parasitoid of *U. jaceae* in Iran (Starý *et al.*, 2000). Many taxonomists have sometimes used the name *P. dorsale* for the species parasitizing *Uroleucon* aphids (Starý, 2006). Having said this, in fact, *P. dorsale* is a parasitoid of *Corylobium* aphids and is a separate species (Tremblay & Pennacchio, 1985; Tremblay *et al.*, 1986). *P. yomenae* is a specific parasitoid of *Uroleucon* species and have a palearctic distribution (Tomanović *et al.*, 2003a). In addition to *U. jaceae* already mentioned by Starý *et al.* (2000), here, three other *Uroleucon* species, viz. *U. sonchi*, *U. chondrillae* and *U. compositae*, are also considered as hosts of *P. yomenae* (see above).

The species of *Praon* show a wide and complex diversity in their associations with aphid species. Except some oligophagous species such as *P. volucre*, several other species prefer specific guilds (Tomanović *et al.*, 2003a, 2003b). Our results, too, present the similar pattern of host associations, as well as some new host records, e.g. *H. lactucae* as a host of *P. orpheusi*. The results of the current study may also contribute to the knowledge of biodiversity, geographical distribution and parasitoid-aphid-plant relationships. More detailed and extensive researches on the distribution and host associations of *Praon* species in Iran are needed to provide information about species richness in specific guilds or in a broader sense. Most probably, some other species of *Praon* occurring in neighbouring areas are distributed in Iran, which needs further studies.

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