

A STUDY OF *PRAON* HALIDAY (HYMENOPTERA: BRACONIDAE: APHIDIINAE) IN SOUTH-EAST IRAN WITH TWO NEW RECORDS

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Abstract

Aphid parasitoids belonging to *Praon* Haliday in Kerman Province (South-East Iran) were studied. Parasitoid species were reared from field-collected aphids, and the tritrophic associations of parasitoids, their aphid hosts, and the respective host plants were identified. In total, 18 tritrophic associations were presented, from which seven host aphids, eight host plants and six host aphid-host plant combinations were new for Iran. Two species, *P. flavinode* (Haliday, 1833) and *P. unitum* Mescheloff & Rosen, 1988, were recorded for the first time from Iran. An illustrated key together with supplementary figures for the identification of species is provided.

KEY WORDS: *Praon*, Aphid parasitoids, Braconidae, Iran, tritrophic associations.

Introduction

Aphids (Hemiptera: Aphidoidea) are one of the most important groups of insects because of their destructive effects on plants by causing direct and also indirect damage as vectors of plant viruses (BLACKMAN & EASTOP, 2006; VAN EMDEN & HARRINGTON, 2007). They have been considered as agricultural pests which are important economically. Aphids, like other insects, have their natural enemies such as parasitoid wasps which play an important role in controlling aphid populations (RAKSHANI, 2006; VAN EMDEN & HARRINGTON,

2007). One of the most important groups of aphid parasitoids belongs to the subfamily Aphidiinae within the family Braconidae. The members of the subfamily Aphidiinae are specialised solitary koinobiont endoparasitoids of aphids (STARÝ, 1970). Aphidiinae includes numerous species which are important agents in biological control programs, and to date a total of 59 species are reported from Iran (STARÝ *et al.*, 2000; RAKHSHANI *et al.*, 2007, 2008 ; KAZEMZADEH *et al.*, 2009). They are used to contribute to controlling aphids in various agro-ecosystems (MACKAUER & STARÝ, 1967; STARÝ, 1970).

Tritrophic association knowledge is an important key factor in the detection of trophic interactions in the communities (KAVALLIERATOS *et al.*, 2005b). More than 55 genera and about 400 species are known in the subfamily Aphidiinae (KAVALLIERATOS *et al.*, 2004b; RAKHSHANI *et al.*, 2007). The genus *Praon* Haliday is one of the largest genera with more than 50 described species worldwide (KAVALLIERATOS *et al.*, 2005b; TOMANOVIĆ *et al.*, 2006b). It is related to the tribe Praini (TOMANOVIĆ *et al.*, 2006b) and up to now two genera, *Praon* and *Areopraon*, belonging to this tribe have been reported from Iran (KAZEMZADEH *et al.*, 2009). One of the most important characteristics of the former genus is the type of pupation which is external (under the host aphid). The species of the genus *Praon* parasitize the numerous and variable aphids (MACKAUER, 1959; KAVALLIERATOS & LYKOURESSIS, 1999-2000, KAVALLIERATOS & TOMANOVIĆ, 2001, TOMANOVIĆ & KAVALLIERATOS, 2002, KAVALLIERATOS *et al.*, 2001, 2003, 2004a, 2005a, b, TOMANOVIĆ *et al.*, 2003a, b, 2006a) and many species of the genus are important biological control agents in various agro- and forest ecosystems (RAKHSHANI *et al.*, 2007).

Several studies were conducted on the fauna and distribution of Aphidiinae in some adjacent countries of Iran such as Iraq (STARÝ & KADDOU, 1971), Turkey (OLMEZ & ULUSOY, 2003; ASLAN *et al.*, 2004; EL-MALI *et al.*, 2004, TOMANOVIĆ *et al.*, 2008a), Georgia (ACHVLEDIANI, 1981) and Pakistan (STARÝ *et al.*, 1998). Similar studies also have been carried out in different parts of Iran. For example, *Praon volucre* was recorded as a parasitoid of *Diuraphis noxia* (Mordvilko) by DOLATI (1994) and ZAREH *et al.* (1995). STARÝ *et al.* (2000) reviewed the aphid parasitoids of Iran and listed them with their aphid hosts which included six species of *Praon*. More extensive works were done by RAKHSHANI *et al.* (2007) who studied distribution and host associations in the genus *Praon* and in the later work identified eight species which included four previously reported species and four new records for Iran.

Most species within the genus show slight morphological differences and great intraspecific variability, such that exact identification is simply not possible using traditional morphological characters (TREMBLAY & PENNACCHIO, 1985; TOMANOVIĆ *et al.*, 2003a,b, 2006b; KAVALLIERATOS *et al.*, 2005b; RAKHSHANI *et al.*, 2007). In this case, sometimes host range is a helpful biological characteristic for identifying the species or species groups (RAKHSHANI *et al.*, 2007; KAVALLIERATOS *et al.*, 2005b).

The aim of this study was to recognize the aphid parasitoids belonging to the genus *Praon* on wild plants in steppes and shrublands in Kerman province, South-Eastern Iran. An identification key together with supplementary figures were constructed for the species of the genus *Praon* occurring in the region.

Materials and Methods

The material from various wild host plants bearing aphid colonies consisting of both live and mummified aphids was collected from many different localities in steppes and shrublands in Kerman province, South-Eastern Iran between 2007 and 2009. Samples were moved to the laboratory and kept at room temperature for 3-4 weeks in mesh covered transparent plastic rearing boxes until the emergence of parasitoids. The

emerged adults were kept alive for two days to complete their pigmentation and then they were preserved in 75% ethanol. In order to have microscopic slides of parasitoids, the adults were slightly boiled in 10% KOH and then washed in distilled water. They were dissected and slide mounted in Hoyer medium. Identification was based on available keys (STARÝ, 1981; MESCHELOFF & ROSEN, 1988; KAVALLIERATOS *et al.*, 2001, 2005a, b, 2008; RAKHSHANI, 2006; RAKHSHANI *et al.*, 2006, 2007; TOMANOVIĆ *et al.*, 2003a,b, 2008b).

Terminology follows (KAVALLIERATOS *et al.*, 2001; TOMANOVIĆ *et al.*, 2003a,b; RAKHSHANI, 2006; RAKHSHANI *et al.*, 2006, 2007). External morphology was illustrated using an Olympus phase contrast microscope with a drawing tube. Measurements were taken using an ocular micrometer.

Host associations are listed as follows: host aphid, host plant, locality (city or village, GPS data and elevation), sampling date and number of samples (in parthensis). New records of parasitoid species, host aphids, host plants, and host aphid-host plant combinations are indicated by an asterisk (*), a dagger (†), two daggers (††) and double dagger (‡) respectively. Material examined in this study is deposited in the collection of the second author at Shahid Bahonar University of Kerman, Iran. All figures are given in Appendix 1.

Results

Five *Praon* species are identified in the present paper. In total, 18 tritrophic associations were recognized, from which seven host aphids, five host plants and six host aphid-host plant combinations are new for Iran. Three previously reported species from Iran, i.e., *P. rosaecola* Starý, *P. volucre* (Haliday) and *P. yomenae* Takada were identified and two species, *P. flavinode* (Haliday) and *P. unitum* Mescheloff & Rosen, were recorded for the first time from Iran.

Parasitoid species and their tritrophic associations

**Praon flavinode* (Haliday, 1833) (Figs. 1, 6, 11, 16, 21, 26)

†*Tinocallis nevskyi* Rem., Quednau & Heie on ‡*Ulmus campestris* L., Kerman (Bardsir, N 29° 56' E 56° 34', 2082m) 31 October 2007 (2♀).

Praon rosaecola Starý, 1961 (Figs. 2, 7, 12, 17, 22, 27)

Macrosiphum rosae (L.) on *Rosa damascena* Mill., Kerman (Lalehzar, N 29° 31' E 56° 45', 2692m,) 09 October 2007 (5♀).

**Praon unitum* Mescheloff and Rosen, 1988 (Figs. 3, 8, 13, 18, 23, 28)

†*Sipha maydis* Pass. on ‡*Cynodon dactylon* (L.), Kerman (Kerman, N 30° 15' E 57° 06', 1771m) 22 November 2007 (1♀); †*Uroleucon acroptilidis* on ‡*Acroptilon repens* DC., Kerman (Kerman, N 30° 14' E 57° 07', 1773m) 08 November 2007 (2♀ 2♂).

Praon volucre (Haliday, 1833) (Figs. 4, 9, 14, 19, 24, 29)

†*Amphorophora catharinae* (Nevsky) on ‡*Rosa damascena* Mill., Kerman (Kouhpayeh, N 30° 29' E 57° 16', 1961m) 24 October 2007 (1♀); *Aphis craccivora* Koch on ††*Portulaca oleracea* L., Kerman (Shahdad, N 30° 24' E 57° 41', 481m) 28 November 2007 (2♀); *Aphis solanella* Theob. on *Solanum* sp., Kerman (Sirch, N 30° 11' E 57° 33', 1723m) 28 November 2007 (2♀ 3♂); *Macrosiphum rosae* (L.) on ††*Rosa damascena* Mill.,

Kerman (Lalehzar, N 29° 34' E 56° 40', 2524m,) 09 October 2007 (7♀ 8♂); *Rhopalosiphum maidis* (Fitch) on ††*Setaria glauca* (L.) P.Beauv., Kerman (Sirch, N 30° 11' E 57° 33', 1721m) 28 November 2007 (1♀ 1♂); *Uroleucon sonchi* (L.) on *Sonchus oleraceus* (L.), Kerman (Lalehzar, N 29° 30' E 56° 48', 2848m) 09 October 2007 (2♀).

Praon yomenae Takada, 1968 (Figs. 5, 10, 15, 20, 25, 30)

†*Acyrtosiphon lactucae* (Pass.) on ‡*Sonchus oleraceus* (L.), Kerman (Lalehzar, N 29° 29' E 56° 48', 2979m) 09 October 2007 (2♀ 3♂); *Uroleucon* sp. on *Acroptilon repens* DC., Kerman (Kerman, N 30° 15' E 57° 06', 1812m) 10 November 2007 (7♀ 4♂); *Uroleucon* sp. on *Acroptilon repens* DC. Kerman (Mahan, N 30° 13' E 57° 06', 1776m) 03 October 2007 (3♀ 4♂); *Uroleucon* sp. on ††*Picnomon acarna* (L.), Kerman (Mahan, N 30° 12' E 57° 05', 1770m) 13 May 2008 (1♀ 1♂); †*Uroleucon cichorii* (Koch) on ‡*Cichorium intybus* L., Kerman (Kouhpayeh, N 30° 28' E 57° 18', 1836m) 24 October 2007 (2♀ 3♂); *Uroleucon jaceae* (L.) on ††*Centaurea iberica* Trev., Kerman (Kerman, N 05° 12' E 33° 45', 1769m) 21 April 2008 (1♀ 1♂); *Uroleucon sonchi* (L.) on *Sonchus* sp., Kerman (Kerman, N 30° 15' E 57° 06', 1773m) 22 November 2007; *Uroleucon sonchi* (L.) on *Sonchus* sp., Kerman (Kerman, N 30° 14' E 57° 07', 1682m) 09 October 2007 (1♀ 1♂); †*Uroleucon acroptilidis* on *Acroptilon repens* DC., Kerman (Kerman, N 30° 14' E 57° 07', 1773m) 09 October 2007 (5♀ 8♂); *Uroleucon sonchi* (L.) on *Sonchus oleraceus* (L.), Kerman (Lalehzar, N 29° 32' E 56° 46', 2704m) 09 October 2007 (2♀); *Uroleucon sonchi* (L.) on *Sonchus oleraceus* (L.), Kerman (Kerman, N 30° 15' E 57° 06', 1763m) 09 November 2007 (2♀ 3♂).

Key to *Praon* species in South-Eastern Iran (based on females) (also see Tab. I)

- 1) Antennae 16-17 segmented, F1 6-6.5 x as long as wide, propodeum with wide central hairless area (Figs. 16, 18) 2
 - Antennae 17-19 segmented, F1 3-5.5 x as long as wide, propodeum without wide central hairless area (Figs. 17, 19, 20) 3
- 2) Forewing M-cu invisible (Fig. 6), F1 6.3-6.5 x as long as wide, F1 entirely yellow, clypeus with 18-20 long setae (Fig. 1) *Praon flavinode* (Haliday)
 - Forewing M-cu present and complete (Fig. 8), F1 6-6.2 x as long as wide, F1 yellowish at base, gradually darkening to brown at apex, clypeus with 22-24 long setae (Fig. 3) *Praon unitum* Mescheloff and Rosen
- 3) F1 entirely yellow, Rs+M and M-cu complete but colorless (Fig. 10) *Praon yomenae* Takada
 - F1 dark, yellowish at base or yellow with at least the apical third dark, Rs+M and M-cu complete, M-cu completely and apical third of Rs+M colored (Figs. 7, 9) 4
- 4) Lateral lobes of mesonotum with wide hairless area (Fig. 12), tergite 1 (petiole) with 3-4 lateral setae and several dorsal setae in middle area of the segment (Fig. 22), clypeus with 15-17 long setae (Fig. 2) *Praon rosaecola* Starý
 - Lateral lobes of mesonotum covered with long setae (Fig. 14), tergite 1 (petiole) with 4-5 lateral setae and several dorsal setae continuing to end of the segment (Fig. 24), clypeus with 18-24 long setae (Fig. 4) *Praon volucre* (Haliday)

Table I. Quantitative characters for *Praon* species in Kerman province, South-East Iran. LP: number of labial palpomeres; MP: number of maxillary palpomeres; NAS: number of antennal segments; F1 and F2: flagellomere 1 and 2; Ult: ultimate segment of flagellum; LPI: longitudinal placodes; Cly: clypeus; St: stigma; Mt: metacarpus; Prop: propodeum; Pt: petiole; 3Val: 3rd valvulae; Sc: scape; Pd: pedicel; In: length; wd: wide; Dr: dorsal; Vn: ventral; Lt: lateral.

Species characters	<i>P. flavinode</i>	<i>P. rosaecola</i>	<i>P. unitum</i>	<i>P. volucre</i>	<i>P. yomenae</i>
LP	3	3	3	3	3
MP	4	4	4	4	4
NAS	16-17	17-18	16-17	17-19	17-19
F1 LPI	0	0	0	0	0
F2 LPI	1-2	0-1	1-2	1-2	2-3
F1 In/wd	6.3-6.5	5	6-6.2	4.6-5	3-5.5
F1/F2 In	1.6-1.7	1.5	1.3-1.5	1.2-1.4	1.2-1.4
F1/Ult In	1.7-2	1.8	1.7	1.5-1.7	1.5-2.1
Cly seta	18-20	15-17	22-24	18-24	22-24
St In/wd	3.1-3.3	3.4-3.8	3.9	4	3.9-4.2
St/Mt In	1.7-2	3.5-3.8	1.9-2.2	2-2.3	1.8-2
Prop wd/ In	1.3-1.5	1.4	1.3	1.6	1.4-1.5
Pt In/wd	1.1	1.2	1.3	1.2-1.3	1.1-1.2
3Val seta					
Dr	5-6	6-7	6-7	5-7	5-7
Vn	2-3	4-5	2-3	3-4	3-4
Lt	4-5	5-6	4-5	5-6	4-5
Sc, Pd, F1	yellow	brown	brown	brown	Yellow

Discussion

With regard to the identification of two species that are recorded here for the first time, it is expected that more species are present in the region, so preparing an identification key is an important task for recognition of species. More morphological and biological investigations in the future will help to construct a complete check list for the species of the genus *Praon* in the region. Iran constitutes a large part of the Iranian plateau. It covers an area of 1,623,779 km² which is located between the eastern Mediterranean area and the Oriental region, and contains elements of different fauna so the diverse topography and climate of Iran makes the country suitable for taxonomic studies (RAKSHANI *et al.*, 2008; MADJZADEH & MEHRPARVAR, 2009). More investigations and sampling are needed to explore the complete identification and distribution of *Praon* species in a similar way as in other aphidiines parasitoids and their tritrophic associations in South-Eastern Iran.

Some morphological differences were found between the species of *Praon* that have been reported previously and the species which were collected from Kerman province in this study (Tab. II). The study of morphological variation which exists between populations of *P. rosaecola*, *P. volucre* and *P. yomenae* from Kerman province compared to populations from other parts of Iran could aid in the understanding of intraspecific variation in morphological characters which exist within these populations in Iran.

Table II. Morphological differences between three *Praon* species from Kerman province and the rest of Iran. NAS: number of antennal segments; F2 LPI: number of longitudinal placodes on flagellomere 2; Cly Hair: number of hairs on clypeus.

Species / Region		Character		
		NAS	F2 LPI	Cly Hair
<i>P. rosaecola</i>	Iran	16 – 17 (15)	0	10 – 12
	Kerman province	17 - 18	0 - 1	15 – 17
<i>P. volucre</i>	Iran	17 – 18 (19)	0	15 – 18
	Kerman province	17 - 19	1 - 2	18 – 24
<i>P. yomenae</i>	Iran	18 – 19 (20)	2	20 – 22
	Kerman province	17 - 19	2 - 3	22 - 24

Conclusions

It is concluded that there is a poor knowledge of aphid parasitoid fauna, distribution and their tritrophic associations in South-Eastern Iran. Derived from the information gained in this study, the following recommendations are presented:

1. More investigations are necessary in order to gain a complete perspective of fauna, distribution and tritrophic association of *Praon* species in South-Eastern Iran.
2. To date, most investigations have been directed predominantly toward specific pest species on different crops but no such studies have been carried out on aphid fauna occurring in desert and mountainous environments which show important species richness.
3. Research on native parasitoid species (especially non-economic species) as potential biocontrol agents especially in a determined region also merits serious attention.
4. The presumed switching of some parasitoid species between different aphid species makes this case a valuable subject for future investigations.

Acknowledgments

We express thanks to Dr. Ehsan RAKHSHANI (Department of Plant Protection, Zabol University, Zabol, Iran) for confirmation of identification of some samples and Dr. Seyed Mansour MIRTADJADINI (Department of Biology, Faculty of Sciences, Shahid Bahonar University, Kerman, Iran) for identification of host plants. Financial support for this research was partially provided by the Biology Department, Shahid Bahonar University of Kerman, Iran. The research work by P. STARÝ was partially funded by the Entomological Institute project Z50070508 (Acad. Sci. of the Czech Rep.).

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СТУДИЈА РОДА *PRAON* HALIDAY (HYMENOPTERA: BRACONIDAE:
APHIDIINAE) У ЈУГОИСТОЧНОМ ИРАНУ
СА НАЛАЗИМА ДВЕ НОВЕ ВРСТЕ

ХОСЕИН БАРАХОЕИ, СЕЈЕД МАСУД МАДДЗАДЕХ, МОХСЕД МЕХРПАРВАР и ПЕТР СТАРИ

Извод

Тема ове студије су паразитоиди афида из рода *Praon* Haliday, сакупљени у провинцији Керман (југоисточни Иран). Паразитоиди су узгајани на афидама сакупљеним у природи. На тај начин одређене су тритрофичке асоцијације паразитоида, афидних домаћина и одговарајућих биљака хранитељки. Представљено је укупно 18 тритрофичких асоцијација у којима је седам афидних домаћина, осам биљака хранитељки и шест комбинација афидних домаћина и биљака хранитељки први пут забележено у Ирану. Присуство две врсте рода *Praon*, *P. flavinode* (Haliday, 1833) и *P. unitum* Mescheloff & Rosen, 1988 је први пут констатовано на територији Ирана. У раду је дат и илустровани кључ за идентификацију врста рода *Praon* на истраживаном подручју.

Received November 10th, 2009
Accepted May 25th, 2010

Appendix 1

Figure captions

- Figure 1. *Praon flavinode* (Haliday), female: Head, Scale bar = 100 micrometer.
- Figure 2. *Praon rosaecola* Starý, female: Head, Scale bar = 100 micrometer.
- Figure 3. *Praon unitum* Mescheloff & Rosen, female: Head, Scale bar = 100 micrometer.
- Figure 4. *Praon volucre* (Haliday), female: Head, Scale bar = 100 micrometer.
- Figure 5. *Praon yomenae* Takada, female: Head, Scale bar = 100 micrometer.
- Figure 6. *Praon flavinode* (Haliday), female: Forewing, Scale bar = 200 micrometer.
- Figure 7. *Praon rosaecola* Starý, female: Forewing, Scale bar = 200 micrometer.
- Figure 8. *Praon unitum* Mescheloff & Rosen, female: Forewing, Scale bar = 200 micrometer.
- Figure 9. *Praon volucre* (Haliday), female: Forewing, Scale bar = 200 micrometer.
- Figure 10. *Praon yomenae* Takada, female: Forewing, Scale bar = 200 micrometer.
- Figure 11. *Praon flavinode* (Haliday), female: Mesonotum, Scale bar = 50 micrometer.
- Figure 12. *Praon rosaecola* Starý, female: Mesonotum, Scale bar = 50 micrometer.
- Figure 13. *Praon unitum* Mescheloff & Rosen, female: Mesonotum, Scale bar = 50 micrometer.
- Figure 14. *Praon volucre* (Haliday), female: Mesonotum, Scale bar = 50 micrometer.
- Figure 15. *Praon yomenae* Takada, female: Mesonotum, Scale bar = 50 micrometer.
- Figure 16. *Praon flavinode* (Haliday), female: Propodeum, Scale bar = 100 micrometer.
- Figure 17. *Praon rosaecola* Starý, female: Propodeum, Scale bar = 100 micrometer.
- Figure 18. *Praon unitum* Mescheloff & Rosen, female: Propodeum, Scale bar = 100 micrometer.
- Figure 19. *Praon volucre* (Haliday), female: Propodeum, Scale bar = 100 micrometer.
- Figure 20. *Praon yomenae* Takada, female: Propodeum, Scale bar = 100 micrometer.
- Figure 21. *Praon flavinode* (Haliday), female: Petiole, Scale bar = 100 micrometer.
- Figure 22. *Praon rosaecola* Starý, female: Petiole, Scale bar = 100 micrometer.
- Figure 23. *Praon unitum* Mescheloff & Rosen, female: Petiole, Scale bar = 100 micrometer.
- Figure 24. *Praon volucre* (Haliday), female: Petiole, Scale bar = 100 micrometer.
- Figure 25. *Praon yomenae* Takada, female: Petiole, Scale bar = 100 micrometer.
- Figure 26. *Praon flavinode* (Haliday), female: Genitalia, Scale bar = 50 micrometer.
- Figure 27. *Praon rosaecola* Starý, female: Genitalia, Scale bar = 50 micrometer.
- Figure 28. *Praon unitum* Mescheloff & Rosen, female: Genitalia, Scale bar = 50 micrometer.
- Figure 29. *Praon volucre* (Haliday), female: Genitalia, Scale bar = 50 micrometer.
- Figure 30. *Praon yomenae* Takada, female: Genitalia, Scale bar = 50 micrometer.





