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 (RAKHSHANI, 2006; VAN EMDEN & HARRINGTON,
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 & ÜLUSOY, 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 damoscena 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 damoscena 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 damoscena 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)

†Acyrthosiphon lactucae (Pass.) on ♦Sonchus oleraceus (L.), Kerman (Lalehzar, N 29° 29′ E 56° 48′, 2979m) 09 October 2007 (2♀ 3♂); Uroleucon sp. on Acroptilum repens DC., Kerman (Kerman, N 30° 15′ E 57° 06′, 1812m) 10 November 2007 (7♀ 4♂); Uroleucon sp. on Acroptilum repens DC. Kerman (Mahan, N 30° 13′ E 57° 06′, 1776m) 03 October 2007 (3♀ 4♂); Uroleucon sp. on ††Picnoman acama (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 Acroptilum 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 17-19 segmented, F1 3-5.5 x as long as wide, propodeum without wide central hairless area (Figs. 17, 19, 20) .................................................................................................................................................. 3

- Antennae 16-17 segmented, F1 6-6.5 x as long as wide, propodeum with wide central hairless area (Figs. 16, 18) .............................................................................................................................................................. 2

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; LPl: 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.

<table>
<thead>
<tr>
<th>Species characters</th>
<th><em>P. flavinode</em></th>
<th><em>P. rosaecola</em></th>
<th><em>P. unitum</em></th>
<th><em>P. volucre</em></th>
<th><em>P. yomenae</em></th>
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**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 (RAKHSHANI et al., 2008; MADJDZADEH & 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 aphidines 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.

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<tr>
<td>Cly Hair</td>
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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.

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References


A study of Praon in SE Iran with two new records


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

ХОСЕИН БАРАХОЕИ, СЕЈЕД МАСУД МАДЈЗАДЕХ, МОХСЕД МЕХРПАРVAR 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 ханитељки 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.

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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.