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An investigation on alfalfa aphids and their parasitoids in different parts of Iran, with a key to the parasitoids (Hemiptera: Aphididae; Hymenoptera: Braconidae: Aphidiinae)

E. Rakhshani[1], A. A. Talebi[1], S. Manzari[2], A. Rezwani[3] and H. Rakhshani[4]
1. Department of Entomology, College of Agriculture, Tarbiat Modarres University, P.O. Box 14115-336, Tehran, Iran, 2. Insect Taxonomy Research Department, Plant Pests & Diseases Research Institute, P.O. Box 1454, Tehran 19395, Iran, 3. Agricultural Entomology Research Department, Plant Pests & Diseases Research Institute, P.O. Box 1454, Tehran 19395, Iran, 4. Department of Plant Protection, College of Agriculture, Esfahan Industrial University, Esfahan, Iran.

Abstract

In the current study some information is presented about the distribution and associations between alfalfa aphids and their parasitoids in different regions in 11 provinces of Iran, as well as an identification key to the parasitoids. The main aphids were *Therioaphis trifolii maculata* (Buckton) and *Acyrthosiphon pisum* (Harris) followed by *Aphis craccivora* Koch and *Acyrthosiphon kondoi* Shinji. The distribution pattern of these aphids showed a discrepancy in different regions. *Therioaphis trifolii maculata* was almost distributed in all studied areas, but *A. craccivora* mostly distributed in lower regions including the deserts of the east and central parts of Iran. *Acyrthosiphon pisum* and *A. kondoi* were mainly occurred in higher altitude regions.

Trioxys complanatus Quilis and *Praon exsoletum* (Nees) were found to be specific parasitoids of *T. trifolii maculata*, and collected, with a few exceptions, in all studied regions. The species of *Acyrthosiphon* were mainly attacked by *Aphidius ervi* Haliday followed by *A. smithi* Sharma & Subba Rao and *A. eadyi* Starý, Gonzalez & Hall. *Lysiphlebus fabarum* (Marshall) was the common parasitoid of *A. craccivora*, but *Ephedrus persicae* Froggatt locally found to show host specificity on this aphid. *Praon volucre* (Haliday) was occasionally found to attack *A. pisum* and *A. craccivora*, but the other parasitoids including *Aphidius colemani* Viereck, *Lysiphlebus confusus* Tremblay & Eady and *Diaeretiella rapae* (McIntosh) were only reared from *A. craccivora*. Considering the occurrence of alfalfa aphids together with their parasitoids in almost all studied areas, it seems that more attention should be paid to the parasitoids of alfalfa aphids, especially the specific ones, along with other control methods in an integrated pest management programme.

Key words: alfalfa, aphids, parasitoids, distribution, Iran

چکیده

در این تحقیق اطلاعاتی در زمینه‌ی پراکنش و رابطه‌ی بین شته‌های یونجه و پارازیتوییدهای آنها در مناطق مختلف یازده استان ایران همراه با کلید شناسایی ارایه می‌گردد. مهمترین شته‌های یونجه عبارت بودند از *Therioaphis trifolii maculata* (Buckton) و *Acyrthosiphon pisum* (Harris) و سپس *Aphis craccivora* Koch و *Acyrthosiphon kondoi* Shinji. الگوی پراکنش این شته‌ها در مناطق مختلف متفاوت بود. *T. trifolii maculata* پراکنش وسیعی تقریباً در کلیه‌ی نواحی مورد مطالعه داشت ولی *A. craccivora* اغلب در نواحی کم‌ارتفاع شامل دشت‌های شرق و نواحی مرکزی ایران پراکنده بود. *A. pisum* و *A. kondoi* عمدتاً در نواحی مرتفع‌تر فعالیت داشتند.

زنبورهای *Trioxys complanatus* Quilis و *Praon exsoletum* (Nees) پارازیتوییدهای اختصاصی شته‌ی *T. trifolii maculata* بوده و تقریباً در اغلب نواحی مورد مطالعه پراکنده بودند. گونه‌های *Acyrthosiphon* اغلب توسط زنبور پارازیتویید *Aphidius ervi* Haliday و سپس *Aphidius smithi* Sharma & Subba Rao و *Aphidius eadyi* Starý, Gonzalez & Hall. مورد حمله قرار می‌گرفتند. زنبور پارازیتویید عمومی شته‌ی *A. craccivora* *Lysiphlebus fabarum* (Marshall) بوده ولی *Ephedrus persicae* Froggatt به طور موضعی روی این شته فعالیت داشت. زنبور *Praon volucre* (Haliday) دارای فعالیت محدود روی شته‌های *A. pisum* و *A. craccivora* بود ولی پارازیتوییدهای دیگر شامل *Aphidius colemani* Viereck، *Lysiphlebus confusus* Trembly & Eady و *Diaeretiella rapae* (McIntosh) به صورت

محدود تنها از روی شتهی *A. craccivora* جمعآوری شدند. با در نظر گرفتن وقوع همزمان شتههای یونجه و پارازیتوییدهای آنها در اکثر نواحی مورد مطالعه، به نظر میرسد که در کنار سایر روشهای کنترل آفات در یک برنامهی مدیریت تلفیقی، میبایستی توجه بیشتری به پارازیتوییدهای شتههای یونجه، مخصوصاً گونههای اختصاصی بشود.

واژگان کلیدی: یونجه، شتهها، پارازیتوییدهای شتهها، پراکنش، ایران

Introduction

Alfalfa, *Medicago sativa*, is the world's most highly valued legume forage crop and has often been referred to as the "Queen" of the forages. It has the highest feeding value of all commonly grown hay crops, producing more protein per hectare than any other crop for livestock. Alfalfa can also improve soil quality, which consequently enhances agricultural profitability (Hanson *et al*., 1988). Several insects have been known to attack alfalfa, of which the aphids are important pests in most cases. For example, *Acyrthosiphon pisum* (Harris) is now virtually worldwide in distribution (Blackman & Eastop, 2000) and is a major pest of alfalfa. In high infestations, severe damages can also occur to peas, due to both direct feeding and virus spread (Bommarco, 1991). *Aphis craccivora* Koch is a cosmopolitan aphid that well distributed in the tropics, where it is one of the most common aphid species (Blackman & Eastop, 2000). Aphid infestations can reduce the feeding value of alfalfa and severe infestations may cause growth retardation, yield reduction and even plant death. Hence, several biological control programs were established in other countries in order to control alfalfa aphids (Lehane, 1982; Wilson *et al.*, 1982; Franzmann *et al.*, 1990).

Alfalfa aphids are a moderately well-known group in Iran and other countries (van den Bosch *et al.*, 1961; Monajemi & Esmaili, 1981; Rezwani, 1987; Lykouressis & Polatsidis, 1990; Sousa-Silva *et al*., 1998). In Iran, there is detailed information on the distribution and population fluctuation of *A. craccivora* on alfalfa in Kerman (Takallozadeh, 2003). Monajemi & Esmaili (1981), and Rassoulian (1985) investigated the population dynamics and natural enemies of alfalfa aphids in Karadj, as well as introducing some aphid parasitoids. In both studies, the main aphids were *Acyrthosiphon kondoi* Shinji, *A. pisum*, *Therioaphis trifolii maculata* (Buckton) and *A. craccivora*. Rassoulian (1985) studied in detail the impact of parasitoids on the dynamism of aphid populations as well as other natural enemies. However, there is no enough information about the taxonomy and distribution of aphid parasitoids in the other parts of the country. It is worth mentioning that González *et al*. (1978) introduced the natural enemies of alfalfa aphids from Iran and Afghanistan, and Starý *et al*. (2000) reviewed host associations of aphid parasitoids in Iran.

The current study provides some information relating to the distribution of alfalfa aphids and their parasitoids in Iran. Also, an identification guide to the parasitoids is presented.

Materials and methods

In order to study aphid-parasitoid associations, several surveys were conducted in the studied areas including unsprayed alfalfa fields in different regions of 11 provinces in Iran (table 1). During these extensive sampling programmes, alfalfa aphids as well as those mummified were collected. The mummified aphids, which collected manually by cutting the leaves on which they had attached, were reared within semi-transparent plastic containers (10 cm in height and diameter) covered with gauze. They were kept for at least 30 days within the containers and the emerged wasps clipped daily.

Adult parasitoids were also collected by sweeping from more than 45 sampling areas to target possible rare species as well as gathering enough information about field distribution in each region. As a result, more than 150 samples were collected and identified using reliable identification keys (Starý, 1979; Starý *et al.*, 1980; Pennacchio, 1989; Kavallieratos *et al.*, 2001). All identifications were confirmed by relevant experts. The terminology used in this study follows that of Pennacchio (1989) and Kavallieratos *et al.* (2001).

Results and discussion

A total of four aphid species, viz. pea aphid, *A. pisum*, blue alfalfa aphid, *A. kondoi*, spotted alfalfa aphid, *T. trifolii maculata* and black alfalfa aphid, *A. craccivora*, were found actively in the studying regions, of which *A. pisum* and *A. kondoi* mostly occurred in higher altitude regions, whereas *A. craccivora* mostly found in lower regions. *T. trifolii maculata* were almost collected in all studying areas (table 1). *Acyrthosiphon pisum* can be confused with *A. kondoi*, but there are some reliable colour differences to separate them. In the latter species, the antennal segment III is uniformly brown, whereas that of *A. pisum* has a narrow dark band apically. Furthermore, the body colour of *A. kondoi* is generally intense blue green, but *A. pisum* is a light-green/yellow aphid.

Therioaphis trifolii maculata, which is a cosmopolitan species and attacks alfalfa and clover (Bueno *et al*., 1996), was widely distributed in the studying area (table 1). It was found in an intense population along with *A. pisum* in mild climate regions, however, its population was also sometimes considerable in deserts of the Sistan and Baluchastan province, and should the reason be investigated in the future.

Table 1. Alfalfa aphid-parasitoid associations sampled in different regions of Iran.

Sampling regions	Aphid species			
	Acyrthosiphon pisum	***Acyrthosiphon kondoi***	***T. trifolii maculata***	***Aphis craccivora***
Tehran				
Tehran	+, Ae	+, Ae	+, Tc, Pe	+, Lf
Karadj	+, Ae, As, Aed	+, Ae, As	+, Tc, Pe	+, Lf, Ac
Mardabad	+			
Shahriar	+		+, Tc, Pe	+, Lf
Varamin	+, Pv		+, Tc, Pe	+, Lf
Quazvin				
Quazvin	+		+, Tc, Pe	+, Lf
Takestan	+, Ae		+, Tc, Pe	+, Lf
Ardabil				
Ardabil			+, Tc, Pe	
Parsabad			+ Tc, Pe	
Zanjan				
Zandjan	+Ae		+, Tc, Pe	
Abhar	+, Ae, Pv	+, Ae	+, Tc, Pe	+, Lf
Markazi				
Saveh	+, Ae		+, Tc	
Hamedan				
Hamedan	+, Ae, As, Aed	+, Ae	+, Tc, Pe	+, Lf
Rovan	+, Ae, As		+, Tc	
Kermanshah				
Kermanshah	+, Ae		+, Tc, Pe	
Kamyaran	+, As		+, Tc, Pe	
Sahneh	+, Ae, As		+, Tc, Pe	+, Lf
Bisotoon			+, Tc, Pe	
Kordestan				
Sanandaj	+, Ae, As		+, Tc, Pe	+, Lf
Marivan	+, As		+, Tc, Pe	+, Lf
Soisheh	+, As		+, Tc, Pe	
Sarvabad			+, Tc, Pe	
Esfahan				
Esfahan	+, Ae		+, Tc, Pe	+, Lf
Shahin Shahr	+, Ae	+, Ae	+, Tc, Pe	
Lavarg	+, Ae, As, Aed	+, Ae	+, Tc, Pe	+, Lf
Borkhar	+, Ae		+, Tc, Pe	+, Lf
Alavijeh			+, Tc, Pe	+, Lf
Khoramgah	+, Ae		+, Tc, Pe	
Ziar			+, Tc, Pe	+, Lf
Sistan-Baluchestan				
Iranshahr			+, Tc	+, Lf, Ac
Dalgan			+, Tc	+, Lf, Dr
Jazmourian				+, Lf
Khash	+, As		+, Pe	+, Lf
Taftan	+, As		+, Pe	
Saravan			+, Tc	+, Lf
Pishin			+, Tc	+, Lf
Nikshahr				+, Lf
Sarbaz			+, Tc	+, Lf
Zabol	+, Ae		+, Tc	+, Lf, Lc, Pv
Zahedan			+, Tc, Pe	+, Lf
Rigzar			+, Pe	
Bonjar			+, Tc	+, Lf, Lc
Zahak			+, Tc	+, Lf, Ep
Rask			+, Tc	+, Lf
Semnan				
Shahroud			+, Tc, Pe	

Ac = *Aphidius colemani*, Ae = *Aphidius ervi*, Aed = *Aphidius eadyi*, As = *Aphidius smithi*, Dr = *Diaeretiella rapae*, Ep = *Ephedrus persicae*, Lc = *Lysiphlebus confuses*, Lf = *Lysiphlebus fabarum*, Pe = *Praon exsoletum*, Pv = *Praon volucre*, Tc = *Trioxys complanatus*. + shows the presence of aphids.

The above-mentioned four aphids were attacked by a relatively known range of parasitoids, so that some of them could be considered as specific parasitoids. A total of 11 aphid parasitoids were collected and identified, recording their associations. *Trioxys complanatus* Quilis was only reared from *T. trifolii maculata* and showed a specific host preference (table 1), the same behavioural characteristic alluded to by Starý (1976) and Hughes *et al*. (1992). The brown mummified aphids parasitized by *T. complanatus* were mostly found on the lower surfaces of leaves and on stems.

Praon exsoletum (Nees) was also only reared from *T. trifolii maculata* and no other aphids were found to be parasitized by this species (table 1). The aphid mummies were on the upper surfaces of leaves along with the cocoon of the parasitoid situated under the mummies, indicating pupation behaviour of *Praon* species (Starý, 1970). Monajemi & Esmaili (1981) reported *P. exsoletum* as a parasitoid of *A. pisum*, but this association was questioned by Starý *et al*. (2000).

Apparently, the distribution areas of aphid species have a relatively major impact on parasitoids. *Therioaphis trifolii maculata*, the most common aphid, was parasitized by *T. complanatus* in the all regions except some parts of Sistan and Baluchestan, i.e. Rigzar, Khash and Taftan, where the parasitoid was *P. exsoletum* (table 1). These two parasitoids were often found together parasitizing *T. trifolii maculata*, but *P. exsoletum* was not collected in several desert climatic areas in Sistan and Baluchestan. However, in Taftan Mountains that have higher altitude than other adjacent areas, *P. exsoletum* was active. It is in accordance with Starý (1976), who mentioned *P. exsoletum* prefers milder climates, but *T. complanatus* is much better adapted to hot semi-desert areas.

The two *Acyrthosiphon* species were attacked by *Aphidius ervi* Haliday, as well as other parasitoids, but the latter species was not reared from the two other alfalfa aphids, *T. trifolii maculata* and *A. craccivora* (table 1). We collected *A. ervi* in diverse regions, showing the wide distribution of the parasitoid in Iran. The mummified aphids parasitized by *A. ervi* were golden in colour and appeared individually or in a group of up to four mummies on the upper surfaces of leaves. They were also larger in size, comparing to *T. trifolii maculata* mummies parasitized by *T. complanatus*. The hole, cut anteriorly between the cornicles by emerging adult *A. ervi*, was round with a lid at the left or right margin.

Aphidius ervi is an oligophagous species and also attacks other species of *Acyrthosiphon*, as well as other aphids (Starý, 1978; Pike *et al*., 2000; Starý *et al*., 2000). This parasitoid is a major factor in reducing aphid numbers in Europe (Starý, 1968) and is probably the most

important parasitoid of blue alfalfa aphid, *A. kondoi*, world-wide. Starý (1983) defined two biotypes of *A. ervi* based on colour patterns: the Asiatic type, with a predominance of yellow pattern and the Euro-Mediterranean type showing a prevalence of darker pattern. We found both colour patterns among the collected specimens of *A. ervi* in different regions. The dark body specimens were mostly collected in Esfahan province, but specimens from other provinces were lighter in colour.

Aphidius smithi Sharma & Subba Rao was also relatively widely distributed and found to show the same host associations as *A. ervi*, but in most cases, only a few adults were reared from the mummified aphids, showing low parasitism. In some areas such as Khash, Taftan, Marivan and Soisheh, *A. smithi* was the only parasitoid attacked *A. pisum*. On the contrary, *A. ervi* was the major and dominant parasitoid in some other regions such as Esfahan and Zabol (table 1). This may be attributed to altitude differences. Unlike *A. ervi*, as indicated in this study, *A. smithi* was more active in higher altitude regions. However, according to Campbell & Mackauer (1973), in western part of North America, particularly in areas with hot and dry summer, *A. smithi* became dominant to *A. ervi*, which may be relating to the differences in biological characters between the strains rather than species. In the other cases in the current study, when both parasitoids were active, *A. ervi* was found to become dominant to *A. smithi*, which is in agreement with McBrein & Mackauer's (1990, 1991) conclusions. Based on laboratory studies, the authors showed that when these two parasitoids searched alone for hosts, *A. smithi* had significantly greater searching efficiency, but when they searched together for the same host, the interference between them reduced the efficiency of *A. smithi*. The patterns of host selection in parasitoids may be both highly complex and variable (Chow & Mackauer, 1984). Studies of Chua *et al*. (1990) on multiple parasitism, which involved hosts parasitized by one species exposed to the other species, indicated that larvae of *A. ervi* were more competitive and survived better to adulthood than larvae of *A. smithi*. These may also be probable reasons for the dominance of *A. ervi* in the present field study, which is worth to be investigated in the future.

As mentioned above, *A. smithi* was found to parasitize both *A. pisum* and *A. kondoi* (table 1). This agrees with the associations recorded for *A. smithi* by González *et al.* (1978), but not in complete agreement with the host specificity of *A. smithi* to *A. pisum*, as stated by Bueno *et al*. (1993).

Aphidius eadyi Starý, Gonzalez & Hall, one of the species parasitizing *A. pisum*, was collected in a limit range of studying regions, viz. Hamedan, Lavarg and Karadj (table 1). The

parasitoid, which has also been recorded from Ardabil (González *et al*., 1978; Starý, 1979), was not reared from the three other alfalfa aphids. According to Starý *et al*. (1980), *A. eadyi* is a specific parasitoid and only parasitizes *A. pisum*. It also attacks *A. kondoi*, but without further successful development.

Among the parasitoids attacking *A. craccivora*, *Lysiphlebus fabarum* (Marshall) was the common parasitoid, whereas *Ephedrus persicae* Froggatt was only collected in Zahak (table 1), heavily parasitizing *A. craccivora*. The reason for the latter uncommon association might be being of the alfalfa field in the neighbourhood of the wheat field, where the population of its cereal aphid, *Schizaphis graminum* (Rondani), had considerably been reduced. However, *E. persicae* has already been reported from Kerman province as a parasitoid of *A. craccivora* (Takallozadeh, 2003), although being a common parasitoid of arboricolous and cereal aphids (Starý *et al.*, 2000).

Furthermore, other parasitoids were also occasionally found to parasitize *A. craccivora*. These include *Aphidius colemani* Viereck, *Lysiphlebus confusus* Tremblay & Eady and *Diaeretiella rapae* (McIntosh) (table 1), of which the latter species is an uncommon parasitoid of *A. craccivora*, especially on alfalfa, and the host association is newly recorded for Iran. However, Kavallieratos *et al*. (2001) reared *D. rapae* from *A. craccivora* on *Cardaria draba* in Greece. *Aphidius colemani* was collected from two distantly located sampling areas, Karadj and Iranshahr. This parasitoid has also reported from Kerman province by Takallozadeh (2003). In Zabol and Bonjar, *L. confusus* induced low parasitism of *A. craccivora* on alfalfa. The same association was reported by Kavallieratos *et al*. (2001) in Greece. In Iran, this parasitoid was also reared from *A. craccivora*, but on *Zygophyllum* sp. and *Astragalus* sp. (Starý *et al.*, 2000).

Several aphid species have been recorded from Iran to be parasitized by *Praon volucre* (Haliday) (Starý *et al.*, 2000). Here, two more host associations are newly recorded, i.e. *P. volucre* parasitizing *A. pisum* and *A. craccivora* on alfalfa (table 1). It is noteworthy that *Praon barbatum* Mackauer has been reported as a parasitoid of *A. pisum* from Ardabil province and Karadj (González *et al.*, 1978; Starý, 1979), but we failed to collect the parasitoid in these areas.

In addition to these 11 braconid parasitoids, *Aphelinus asychis* Walker (Hym., Aphelinidae) was also occasionally collected, but, at least in the studying areas, it was not found to be an effective biological control agent. Monajemi & Esmaili (1981) also found this parasitoid in a low population in Karadj. However, *A. asychis* was imported from Iran into the

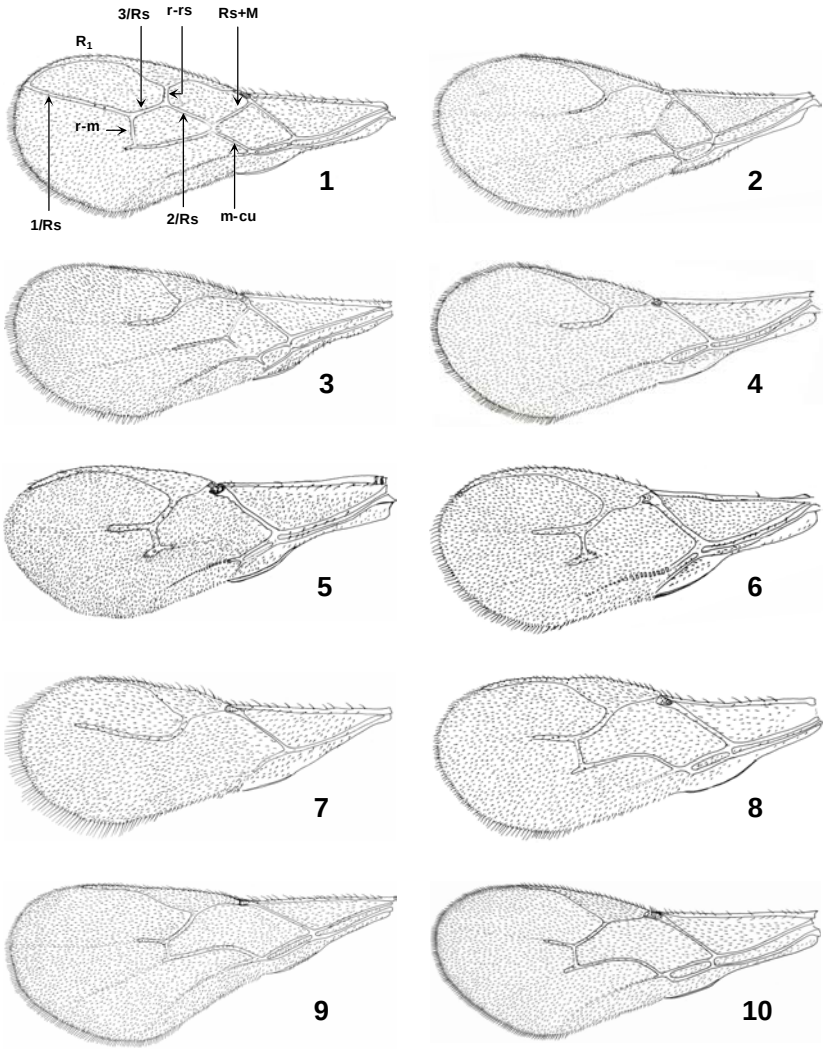
United States of America (van den Bosch *et al.*, 1964) and became established as an important natural enemy of *T. trifolii maculata* (Carver, 1989).

Here, the braconid parasitoids showed a close association with their hosts on alfalfa throughout the season, but in some cases, they were unable to decrease aphid populations adequately. This is maybe due to the fast growth rate of aphids in favourable conditions, and also the application of pesticides used for the control of alfalfa weevil, *Hypera postica* (Gyllenhal), which may have a negative impact on the parasitoids. The lack of enough information on the efficiency of aphid parasitoids, their population fluctuations, and the occurrence and efficiency of other natural enemies makes it difficult to propose an efficient method to control alfalfa aphids. However, based on the current information, it seems that more attention should be paid to the conservation and application of alfalfa aphid parasitoids, especially the specific ones, along with other control methods.

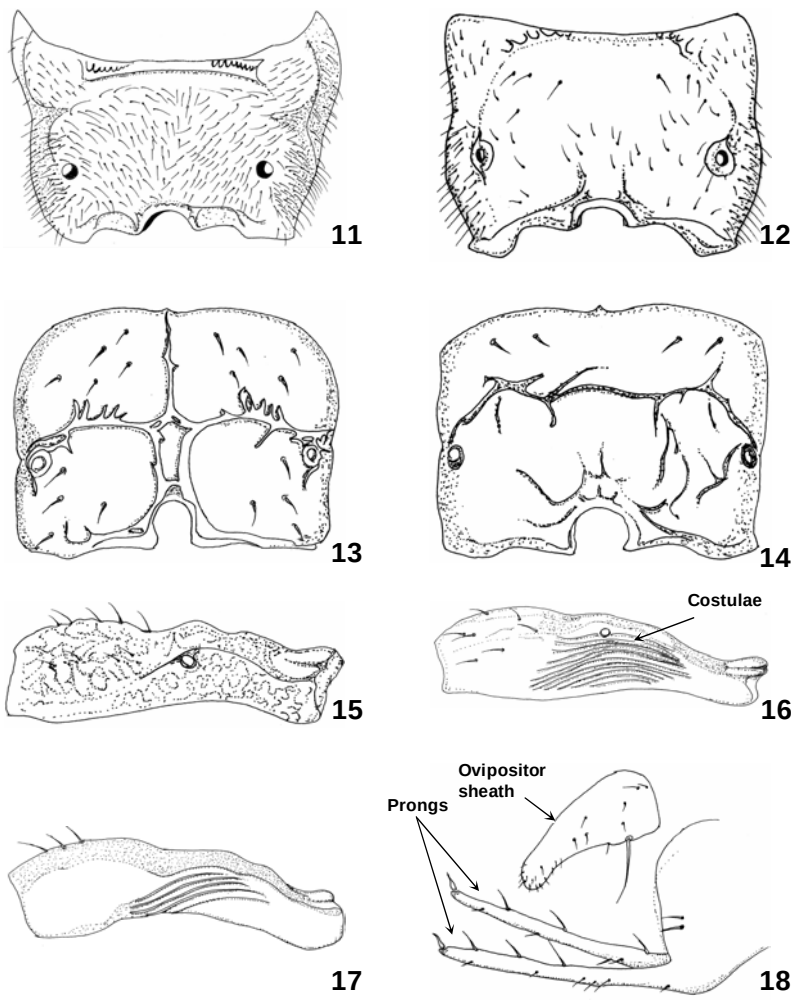
The key presented below may be used to identify the above-mentioned braconid species collected in this study as parasitoids of alfalfa aphids.

Key to female braconid parasitoids of alfalfa aphids

1. Forewing venation complete, with seven closed cell, 1/Rs reaching the margin of wing, 3/Rs shorter than 2/Rs (fig. 1); mummified aphids dark brown to black…… ……..…… ***Ephedrus persicae*** **Froggat**
- Forewing venation not complete, with four closed cells or fewer, 1/Rs not reaching the margin of wing (figs 2-10)…… **2**
2. Forewing with Rs+M present and coloured anteriorly (figs 2, 3); notaulices complete and distinct throughout; propodeum smooth and pubescent (figs 11, 12); parasitoid pupation occurs within a cocoon under the mummified aphid……...…….. **3**
- Rs+M in forewing absent (figs 4-10); notaulices not complete or absent; propodeum areolated (fig. 13) or carinated (fig. 14), and or smooth but not pubescent; parasitoid pupation occurs within the empty body of the mummified aphid…….…….. **4**
3. Flagellomere I yellow; m-cu in forewing effaced or absent (fig. 3); propodeum sparsely pubescent (fig. 12); lateral lobes of mesoscutum with a hairless area; body brown with a dark patch on mesonotum……. ***Praon exsoletum*** **(Nees)**
- Flagellomer I dark brown with a basal yellowish ring; forewing with well-developed m-cu (fig. 2); propodeum densely pubescent (fig. 11); lateral lobes of mesoscutum pubescent; body dark brown to black, metasoma lighter…… ***Praon volucre*** **(Haliday)**



Figures 1-10. Forewing. 1. *Ephedrus persicae*; 2. *Praon volucre*; 3. *Praon exsoletum*; 4. *Diaeretiella rapae*; 5. *Lysiphlebus fabarum*; 6. *Lysiphlebus confuses*; 7. *Trioxys complanatus*; 8. *Aphidius colemani*; 9. *Aphidius smithi*; 10. *Aphidius eadyi*.



Figures 11-18. Propodeum: 11. *Praon volucre*; 12. *Praon exsoletum*; 13. *Aphidius ervi*; 14. *Trioxys complanatus*. Tergit I: 15. *Aphidius ervi*; 16. *Aphidius smithi*; 17. *Aphidius colemani*. Female genitalia: 18. *Trioxys complanatus*.

4. M, m-cu and r-m in forewing completely absent (figs 4, 7)…….. **5**
- M and m-cu in forewing complete (figs 8, 9, 10) or partly absent (figs 5, 6), r-m present, colored or transparent……. **6**
5. Terminal metasomal sternum with two straight prongs, each possessing 3-4 hairs on dorsal surface and one claw-shaped bristle at apex (fig. 18); ovipositor sheath broad, with small scattered hairs near the apex (fig. 18)…….... ***Trioxys complanatus*** **Quilis**
- Terminal metasomal sternum without prongs; antennae 13 or 14-segmented…….. ……... ***Diaeretiella rapae*** **(McIntosh)**
6. M and m-cu in forewing united, forming M+m-cu (figs 8, 9, 10); propodeum with a narrow central pentagonal areola (c f. fig. 13)…….... **8**
- M+m-cu in forewing partly absent (figs 5, 6); propodeum smooth……... **7**
7. Lower and apical marginal setae of forewing as long as those on the wing surface (fig. 5) …… ***Lysiphlebus fabarum*** **(Marshall)**
- Lower and apical marginal setae of forewing longer than those on the wing surface (fig. 6)……. ***Lysiphlebus confusus*** **Trembly & Eady**
8. Anterolateral area of metasomal tergit I rugose (fig. 15)…… ***Aphidius ervi*** **Haliday**
- Anterolateral area of metasomal tergit I costate (fig. 17) or costulate (fig. 16)……. **9**
9. Anterolateral area of metasomal tergit I costate (fig. 17); antenna 15 or 16-segmented..…. …… ***Aphidius colemani*** **Viereck**
- Anterolateral area of metasomal tergit I costulate (fig. 16)…… **10**
10. Pterostigma 1.2-1.3 times as long as metacarpus (fig. 9)…… ……... ***Aphidius smithi*** **Sharma & Subba Rao**
- Pterostigma 1.5-2.0 times as long as metacarpus (fig. 10)…… **...**……... ***Aphidius eadyi*** **Stary, Gonzalez & Hall**

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