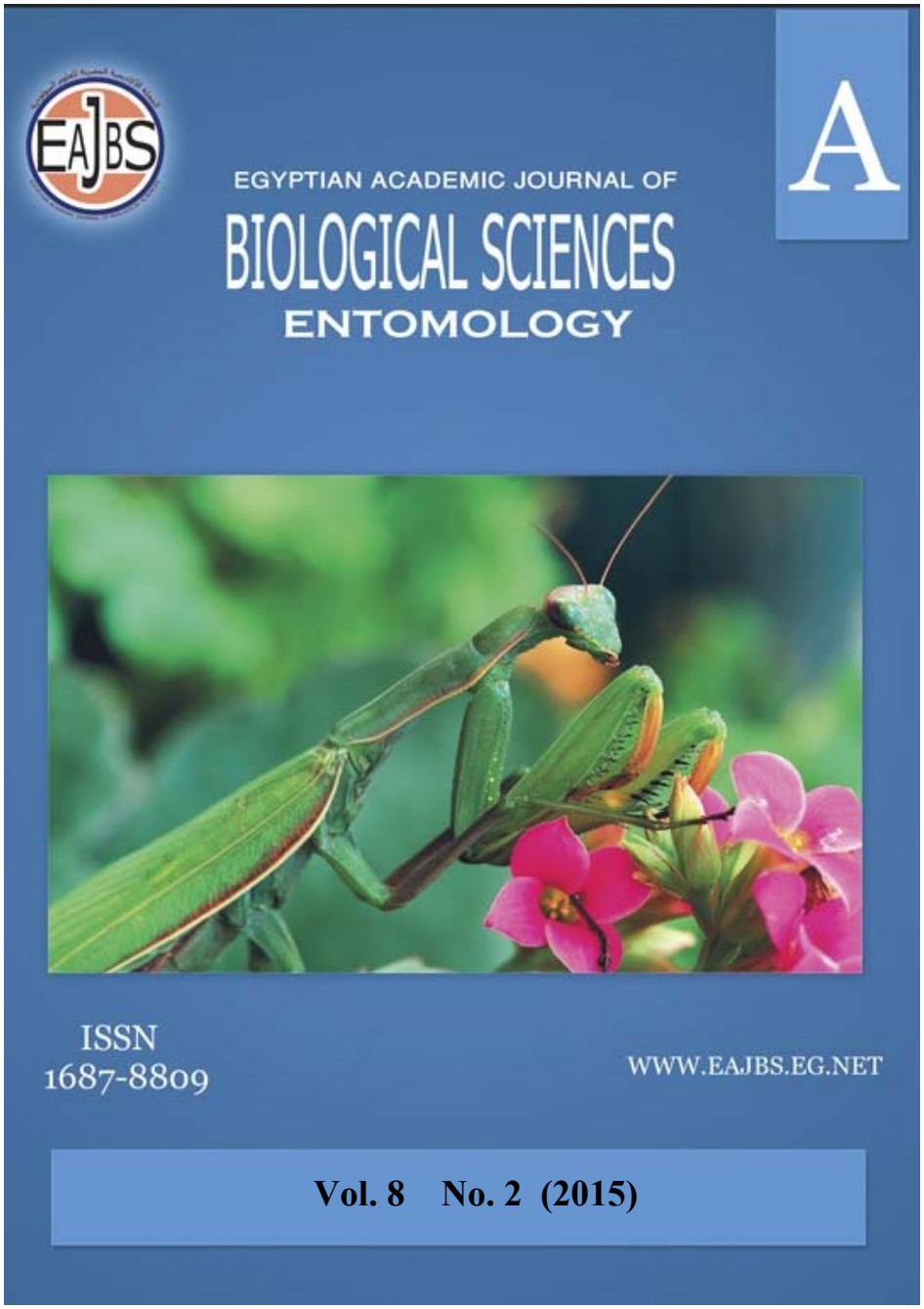


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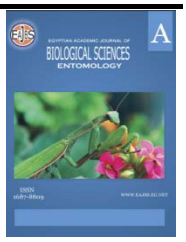

# Species Richness and Abundance of Hymenopterous Parasitoids of the Family of Braconidae (Subfamily Aphidiinae) Within A barley Agro-ecosystem in Hail Region, Saudi Arabia.

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## ABSTRACT

Subfamily Aphidiinae has diverse parasitoid species that are known as solitary endoparasitoids of aphid pests with a comprehensive distribution. Thus, the present study was conducted as a preliminary study to investigate the species richness and abundance of the family of Braconidae (Subfamily Aphidiinae) within a commercial barley crop between February and April 2013 in Hail region, northern Saudi Arabia. Results showed that five species of Aphidiinae were captured within the barley agroecosystem in this region. These included the following: *Lysiphlebus fabarum* (Marshal, 1896), *Binodoxys angelica*e (Haliday, 1833), *Ephedrus persicae* (Froggatt, 1904), *Aphidius colemani* (Viereck, 1912) and *Pauesia* sp. However, *L. fabarum* was found to be the dominant species (67.70%) in the abundance compared to the other species, whereas *Pauesia* sp. was found to be a much rarer species (3.23%) in the barley agroecosystem. Moreover, the results revealed a higher weekly variation in the abundances of the collected Braconid species during the cropping season of barley. The higher abundance of some of the Braconid species in this study could be attributed to the presence of uncultivated crops (weeds) which provide suitable conditions for increasing the abundance of the Braconid species. On the whole, this study suggests that more survey studies for investigating the Hymenopterous parasitoids in many ecosystems in Hail region are required for the successful implementation of biological control program in this region.

## INTRODUCTION

Nowadays, there are growing concerns of the extensive use of synthetic pesticides for controlling pests in agro-ecosystems, and their negative impacts on human health and the environment (Asiry, 2015). Biological pest control is considered as an important ecosystem service and an alternative to the extensive chemical pesticides application (DeBach and Rosen, 1974; Coll and Bottrell, 1995; Bale *et al.*, 2008). Biological control is the regulation of pest species by using natural enemies including its parasites, parasitoids, predators, and pathogens in crops (DeBach and Rosen, 1974; Bale *et al.*, 2008). In recent years, there is a growing interest for conserving natural enemies through enhancing naturally occurring predators and parasitoids through the modification of the environment or of existing pesticide practices to foster the survival, fecundity, longevity, and behavior of these natural

enemies to enhance natural pest control (Barbosa, 1998). This method can be described as an important part of biological pest control and mainly known as the conservation biological control (Barbosa, 1998).

Hymenopterous parasitoids are the most important biological control group for controlling many crop pests and can work as a keystone species, due to their high diversity and hosts specificity (LaSalle and Gauld, 1993; Barbosa, 1998; Rakhshani *et al*., 2013). However, a suite of primary parasitoids are mainly derived from the subfamily Aphidiinae (Braconidae) which is known as solitary endoparasitoids of aphid pests with a global distribution (Kąkol and Miętkiewski, 2001; Dębek-Jankowska and Barczak, 2005a; Barahoei *et al.*, 2013; Rakhshani *et al.*, 2013). Worldwide, about 60 genera and subgenera and more than 400 parasitoids species taxonomically belong to the subfamily Aphidiinae (Starý, 1988).

There is increasing evidence that disturbances in agricultural lands can negatively affect parasitoids community by reducing species richness, abundance and effectiveness within their habitat (Barbosa, 1998). In cropping systems, many factors that can limit parasitoid effectiveness can be seen during disturbances (Barbosa, 1998; Bortolotto *et al*., 2015). These factors include both abiotic factors such as fires, windstorms, floods, landslides and physical factors, and biotic factors such as insects or disease outbreaks (Barbosa, 1998; Bortolotto *et al*., 2015). However, non-crop plants (weeds) can positively increase parasitoid effectiveness by providing richly structured vegetations, alternative host, plant resources (pollen and nectar) and suitable microhabitats for parasitoids (Barbosa, 1998). Understanding how these factors affect parasitoids community can lead to the success of biological control programs (Barbosa, 1998). In addition to that, conducting survey studies on local fauna to investigate whether parasitoids are native or not is equally important for the success of aphid control based on plant-aphid-parasitoid associations (Nazari *et al.*, 2012). The aim of the current study is to investigate the Hymenopterous parasitoids of the family of Braconidae (Subfamily Aphidiinae) within a commercial barley crop in Hail region, in terms of species composition, abundance and the population dynamic of this group.

## MATERIALS AND METHODS

### Study Area

In spring 2013, a field experiment was conducted in a private farm located in Al-Hommamh village (East of Hail region, 27°54.746'N, 42°03.306'E, elevation 783.8m). In this farm, conventional barley crop (*Hordeum vulgare* L.) was planted on 29$^{th}$ December 2012 in 14 hectares of a central irrigation system. Nitrogen fertilizer at 200 kg/ha in the form of ammonium nitrate was applied three times at bed preparation. However, application of pesticides was not applied in this crop production. Six line-transects were determined in the middle of this field before starting the experiment in, each line-transect was 100 m in length and 50 m spaced.

### Parasitoids collection

Through the cropping season of barley, parasitoids were weekly monitored by using a sweep net (38cm in diameter) starting from the middle of February until the beginning of April 2013. In each line-transect, 50 full 180º sweeps were taken and placed in a separate plastic bag (Jacob and Evans, 1998), with a total of 300 sweeps sampled every week from the six line-transects. These six plastic bags containing the specimens were returned to the laboratory for subsequent storage and sorting. All specimens were kept in 70% Ethanol for future identification.

**Parasitoids identification**

The collected parasitoids were counted and identified to genus and species levels using identification keys (Tomanovic *et al.*, 2012; Rakhshani *et al.*, 2012; Starý *et al.*, 2014).

**Statistical analyses:**

The number of counted parasitoids was separately summed for each species in a particular experimental line-transect and across the sampling dates. Means, standard errors of both summed abundance and sampling date (7 points) and percentages of each species were preformed using the statistical analysis package SPSS® 14.0 for Windows.

## RESULTS

A total of 2135 Hymenopterous parasitoids, within five species were captured from the six line-transects within the barley crop in Hail region between February and the beginning of April 2013. Data revealed that all these five species belonged to the Braconidae family (Subfamily Aphidiinae) including the following: *Lysiphlebus fabarum* (Marshal, 1896), *Binodoxys angelica*e (Haliday, 1833), *Ephedrus persicae* (Froggatt, 1904), *Pauesia* sp. and *Aphidius colemani* (Viereck,1912). Results showed that *L. fabarum* was the most abundant species compared to the other species, with a total of 1445 individuals (240.83 ± 63.88) and 67.70% of all species within the barley agro-ecosystem (Table 1 & Fig. 1). This species were followed by *E. persicae* (333 individuals (55.50 ± 8.01) and 15.60%), *A. colemani* (196 individuals (32.70 ± 7.73) and 9.18%), *B. angelicae* (92 individuals (15.33 ± 5.08) and 4.31%) and *Pauesiae* sp. (69 individuals (11.50 ± 4.79) and 3.23%) (Table 1 & Fig. 1).

Table 1: Summed numbers, Means, Standard Errors (±SE), and Percentages (%) of Braconid species during the cropping season of barley (Spring 2013) in Hail region (Mean ± SE: the abundance value of each species is the mean of six line-transects and standard errors (±SE) of means).

| Species Name | Summed Number | Mean ± SE | Percentage (%) |
|---|---|---|---|
| *Lysiphlebus fabarum* | 1445 | 240.83 ± 63.88 | 67.70 |
| *Binodoxys angelicae* | 92 | 15.33 ± 5.08 | 4.31 |
| *Ephedrus persicae* | 333 | 55.50 ± 8.01 | 15.60 |
| *Pauesiae spec* | 69 | 11.50 ± 4.79 | 3.23 |
| *Aphidius colemani* | 196 | 32.70 ± 7.73 | 9.18 |
| **Total** | 2135 | - | 100 |

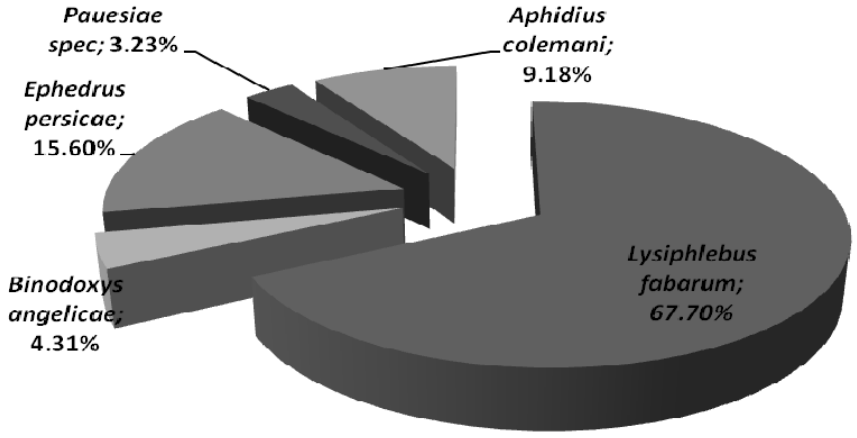


Fig. 1: Percentages (%) of the collected Braconid species during the cropping season of barley (Spring 2013) in Hail region.

The temporal distributions of Hymenopterous parasitoids throughout the cropping season are presented in (Fig. 2). *Lysiphlebus fabarum* showed a peak of its abundance in the beginning of the cropping season (middle of February) (92.33±46.21). The abundance of *L. fabarum* sharply decreased in the next sampling week (22.33±4.48) (Fig. 2). However, the abundance of *L. fabarum* peaked again in both the beginning of March (36.33±12.84) and the end of March (34.33±4.75) (Fig. 2). The trends of the population dynamics of other Hymenopterous parasitoid species were similar during the barley cropping season. In these trends, *E. persicae*, *A. colemani* and *B. angelica*e showed a density peak in the beginning of March in which their mean abundances were (16.33±3.80), (9.50±4.57) and (6.33±3.08), respectively (Fig. 2). Nevertheless, the abundance of *Pauesiae* sp. increased only at the end of the season (end of March) showing one peak over the cropping season (8.50±4.79) (Fig. 2).

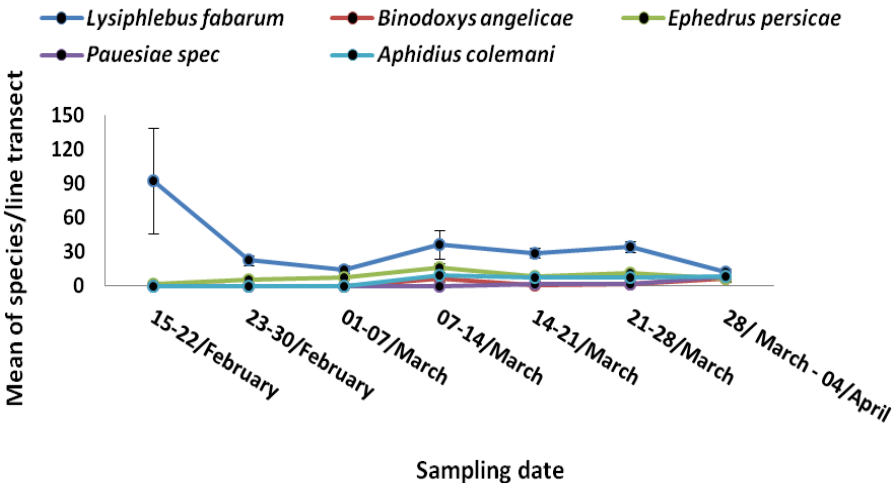


Fig. 2: The population dynamics of the collected Braconid species within the barley agro-ecosystem in Hail region (Spring 2013). The abundance value of each species is the mean of six line-transects. Vertical error bars represent standard errors (±SE) of means.

## DISCUSSION

Hymenopterous parasitoids are known as an important biological control agent for regulating the population size of aphid pests within the field setting (LaSalle and Gauld, 1993, Kąkol and Miętkiewski, 2001). The family Braconidae has plenty species that are known as natural regulators of aphid populations (Starý, 1988; Rakhshani *et al.*, 2013). The current study found out a diverse species of the family of Braconidae (Subfamily Aphidiinae) within the barley agroecosystem in Hail region which is positioned in the north central part of Saudi Arabia. The species that were found by this study include: *L. fabarum*, *B. angelica*e, *E. persicae* , *Pauesia* sp. and *A. colemani*. Most of these species are recorded for the first time from Saudi Arabia in the present study, although Zubair and Bakr (2013) recorded *A. colemani* for the first time in Saudi Arabia, particularly in Asir region which is located in the south□west of Saudi Arabia.

The occurrence of a diverse species of Braconidae in this study possibly could be attributed to either the topography of Hail region which has diverse ecosystems or to the widespread availability of weed species within the cultivated areas of this region (El-Ghanim *et al.*, 2010). El-Ghanim *et al.* (2010), during their study of the floristic composition and vegetation features of Hail's plants, has showed that 52

species were dominated by weeds within the cultivated areas in this region. Weeds may provide a richly structured vegetation, alternative host, plant resources (pollen and nectar) and suitable microhabitats, which are all suitable conditions for Hymenopterous parasitoids (Barbosa, 1998; Marshall *et al.*, 2003; Sutherland *et al.*, 2006). This effect can be seen in the finding of a higher abundance of some Braconid parasitoids in the current study such as *L. fabarum* which represented a dominant species in this study, totaling 1445 individuals, *E. persicae* (333 individuals) and *A. colemani* (196 individuals) throughout the cropping season of barley in Hail region. This finding is consistent with other studies that reported higher abundances of Braconid species that were parasitized on different aphid pests within many different crops such as cotton (Kavallieratos *et al*., 2002), alfalfa (Rakhshani *et al*., 2006) and wheat (Rakhshani *et al*., 2008).

The results of the present study showed that the temporal distributions of the Braconid species varied from week to week in their abundances, showing a peak abundance of *L. fabarum* in the beginning of the cropping season. Here also, weeds and other cultivated crops could play a central role for increasing the abundance of Hymenopterous parasitoids before the arrival of aphid pests to their hosts (Bortolotto *et al*., 2015). This can explain in part why the mean abundance of *L. fabarum* was higher in the beginning of cropping season; this is because *L. fabarum* could increase its abundance throughout attacking other aphids that can be found in weeds or other cultivated crops located near to the barley crop. In addition, variation in the temperature can affect the survivorship of the Hymenopterous parasitoids (Bortolotto *et al*., 2015). Bortolotto *et al*. (2015) concluded that the temperature is an important factor affecting the occurrence of the Braconid species within local ecosystems. This could justify the higher variation in the temporal distributions of the collected Braconid species throughout the cropping season in the current study.

This study showed for the first time a diverse occurrence of Braconid species within a commercial barley crop in Hail region, Saudi Arabia. Hail region lies within the arid zone with a desert climate and has many different ecosystems (Sher and Aldosari, 2012). Conducting a survey research for investigating the Hymenopterous parasitoids in Saudi Arabia is very important for the biological control program. Moreover, Hail region is considered as an agricultural area and most of the farmers in this region apply pesticides for controlling pests in their farms (Asiry *et al*., 2013). This can negatively affect the existing natural enemies including the Braconid species which play a vital role for regulating their aphid pests within agroecosystems. The current study suggests that more studies on the biodiversity and conservation of Braconid species are required in this region.

## ACKNOWLEDGE

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## ARABIC SUMMERY

# ثراء الأنواع والوفرة العددية لطفيليات غشائية الاجنحة من عائلة براكوندى (فصيلة Aphidiinae) داخل النظام البيئي الزراعى للشعير في منطقة حائل بالمملكة العربية السعودية.

**خالد علي عسيرى**
قسم الاحياء – كلية العلوم – جامعة حائل- المملكة العربية السعودية

تحوي تحت فصيلة الـ Aphidiinae على تنوع واسع من الطفيليات المختلفة التي تعرف باسم الطفيليات ذات التطفل الانفرادي لآفات المن ذات التوزيع العالمي. وبسبب هذا فقد أجريت هذه الدراسة كدراسة تمهيدية لمعرفة ثراء الأنواع والوفرة العددية لعائلة الـ Braconidae (تحت فصيلة Aphidiinae) داخل محصول الشعير التجاري في الفترة ما بين فبراير وأبريل لعام 2013 في منطقة حائل الواقعة شمال المملكة العربية السعودية. أظهرت النتائج وجود خمسة أنواع من الـ Aphidiinae تم حصرها في النظام البيئي الزراعي لمحصول الشعير في هذه المنطقة. وتتضمن تلك الانواع ما يلي: *Lysiphlebus fabarum* (Marshal, 1896), *Binodoxys angelica*e (Haliday, 1833), *Ephedrus persicae* (Froggatt, 1904), *Aphidius colemani* (Viereck,1912) and *Pauesia* sp. ومع ذلك، فإن نوع الـ *L. fabarum* ظهر كنوع سائد (67.70٪) من حيث الوفرة العددية بالمقارنة مع الأنواع الأخرى، في حين أن جنس *Pauesia* sp. ظهر كنوع نادر من حيث الوفرة العددية (3.23٪) في النظام البيئي الزراعي لمحصول الشعير. كما كشفت النتائج تفاوتاً في وفرة أنواع عائلة الـ Braconidae من اسبوع إلى آخر خلال موسم زراعة الشعير. ويمكن أن يعزى التفاوت في وفرة بعض الأنواع لعائلة الـ Braconidae في هذه الدراسة لوجود بعض أنواع الأعشاب بجانب الشعير و التي وفرت لهم الظروف المناسبة للتكاثر والازدياد. توصي هذه الدراسة إلى ضرورة اجراء المزيد من الأبحاث لحصر الطفيليات الحشرية في العديد من النظم البيئية في منطقة حائل والذي سوف يكون له الأثر البالغ في نجاح برنامج المكافحة الحيوية في هذه المنطقة.