

## Aphids and their parasitoid Hymenoptera in Oum El Bouaghi Province (Algeria)

Fatima GAGUI<sup>1</sup>, Malik LAAMARI<sup>2</sup>, Souad TAHAR-CHAOUICHE<sup>3</sup> & Djemoui MERZOUG<sup>4</sup>

<sup>1</sup>University Laarbi Ben Mhidi Oum El Bouaghi, Algeria, E-mail: [gaguibio@hotmail.fr](mailto:gaguibio@hotmail.fr) <http://orcid.org/0000-0002-6296-6180>

<sup>2</sup>Laboratory of ATPPAM, Department of Agronomy, Institute of Veterinary and Agronomy Science, University of Batna, 05000, Algeria, E-mail: [laamarimalik@yahoo.fr](mailto:laamarimalik@yahoo.fr)

<sup>3</sup>Scientific and Technical Research Centre for Arid Areas (CRSTRA) Biskra, Algeria, E-mail: [souadhouda@gmail.com](mailto:souadhouda@gmail.com)

<sup>4</sup>University Laarbi Ben Mhidi Oum El Bouaghi, Email: [merzmoui@yahoo.fr](mailto:merzmoui@yahoo.fr)

Correspondence: Fatima GAGUI, [gaguibio@hotmail.fr](mailto:gaguibio@hotmail.fr)

Manuscrit reçu le 4/10/2022 ; accepté le 30/06/2023 ; mis en ligne le 24/07/2023

**Abstract** In order to recognize the plants that might be considered as hosts of aphids and parasitoid activity, this research was undertaken in Oum El Bouaghi province (Northeastern Algeria) to determine the nature of these associations in different habitats. Aphid and parasitoid samples collected directly from infested plants and were conserved in 70% ethanol for identification. A total of thirty-four species of aphids were identified. *Aphis craccivora*, *Aphis fabae* and *Brachycaudus helichrysi* may be defined as broadly polyphagous, with respect to their host range pattern. In this study, the range of parasitoids comprised seven species that parasitized only eight aphid species. *Lysiphlebus testaceipes* was the most polyphagous and common parasitoid species. This introduced species was found in seven tri-trophic associations, which make it the first candidate for biological control against many species of aphids. We report several wild plant species as reservoirs of parasitoids, which are potential regulators of many aphid pest species e.g. *Marrubium vulgare* that can attract four species of parasitoids.

**Key words** Aphids, parasitoid hymenoptera, plant, polyphagous, *Lysiphlebus testaceipes*, Oum El Bouaghi, Algeria.

## Les pucerons et leurs hyménoptères parasitoïdes dans la wilaya d'Oum El Bouaghi (Algérie)

**Résumé** Afin de reconnaître les plantes qui peuvent être considérées comme hôtes de l'activité des pucerons et des parasitoïdes, cette recherche a été entreprise dans la province d'Oum El Bouaghi (Nord-Est de l'Algérie) pour déterminer la nature de ces associations dans différents habitats. Les échantillons de pucerons et de parasitoïdes prélevés directement sur les plantes infestées ont été conservés dans de l'éthanol à 70 % en vue de leur identification. Au total, trente-quatre espèces de pucerons ont été identifiées. *Aphis craccivora*, *Aphis fabae* et *Brachycaudus helichrysi* peuvent être définis comme largement polyphages, en ce qui concerne leur gamme d'hôtes. Dans cette étude, la richesse en parasitoïdes comptait sept espèces qui ne parasitaient que huit espèces de pucerons. *Lysiphlebus testaceipes* était l'espèce parasitoïde la plus polyphage et la plus commune. Cette espèce introduite a été trouvée dans sept associations tri-trophiques, ce qui en fait le premier candidat pour la lutte biologique contre de nombreuses espèces de pucerons. Nous signalons plusieurs espèces de plantes spontanées comme réservoirs de parasitoïdes qui sont des régulateurs potentiels de nombreuses espèces de pucerons ravageurs, comme par exemple *Marrubium vulgare* qui peut attirer quatre espèces de parasitoïdes.

**Mots-clés** Pucerons, hyménoptères parasitoïdes, plante, polyphage, *Lysiphlebus testaceipes*, Oum El Bouaghi, Algérie.

## Introduction

Aphid species have an economic importance all over the world as vectors of plant diseases and as direct plant-sucking pests (RUBERSON, 1999). They can colonize 3000 species of herbaceous plants and shrubs (BLACKMAN & EASTOP, 2000).

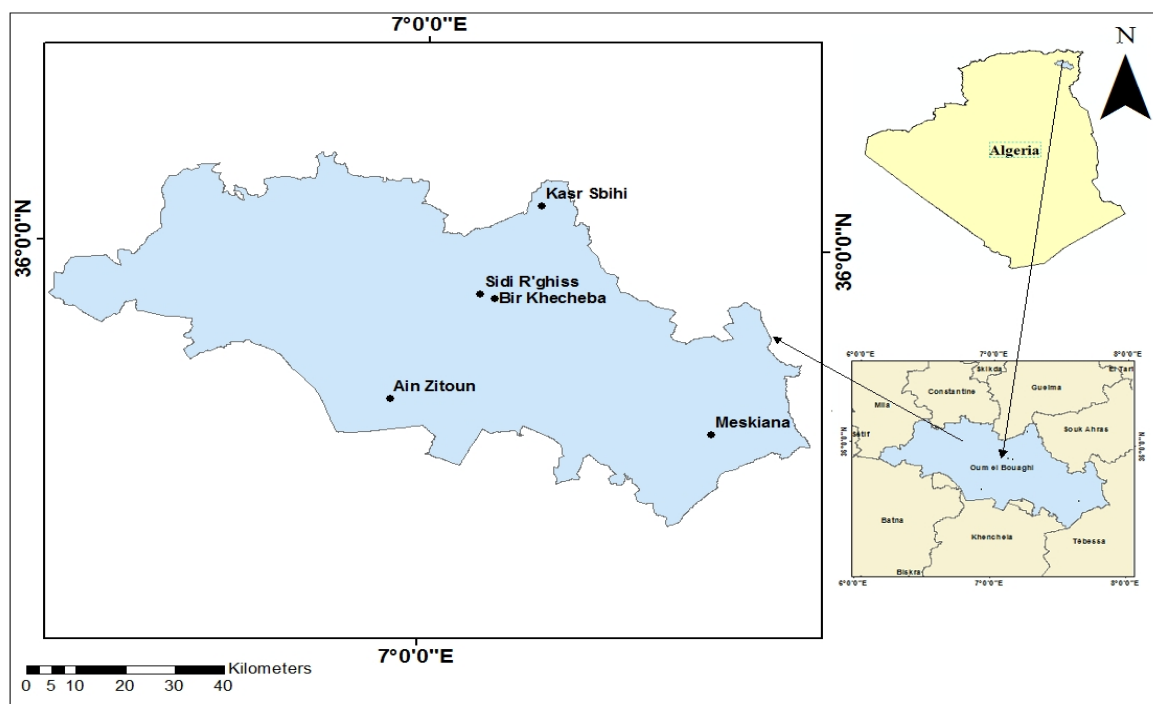
During recent years increasing attention has been directed toward other forms of pest control than the use of chemical pesticides as many aphid species have developed a resistance to insecticides (HANSON *et al.*, 2017). In natural habitats, the Aphidiinae parasitoids provide an important ecosystem service by regulating aphid populations (STARY, 1976). Currently and in order to control pests, exotic species were introduced into many countries (VAN LENTREN *et al.*, 2006), but the problem is how to maintain the balance between environmental benefits and costs that mainly affect native species such as *Lysiphlebus testaceipes* which has become widely established in most parts of Mediterranean region.

Despite the economic importance of aphids, these insects have been poorly studied in Algeria (LAAMARI & COEUR D'ACIER, 2010) and it was only in recent years that different species were recorded (LAAMARI *et al.*, 2013). Subsequent studies (ABDESSEMED, 1998; LAAMARI *et al.*, 2011; LAAMARI *et al.*, 2012) on aphid parasitoids were undertaken in order to evaluate which *Aphidiinae* were present in different Algerian provinces and to understand better the composition of the existing tri-trophic associations.

Among insect parasitoids, all members of the Braconid subfamily Aphidiinae are solitary endoparasitoids of aphids, and more than 400 species are known (STARY, 1988; BOIVIN *et al.*, 2012). This fauna has been investigated by many studies in Europe: (STARY *et al.*, 1973; TOMONOVIC *et al.*, 2012; KAVALLIERATOS *et al.*, 2004, 2008), in the Middle East (STARY *et al.*, 1993; KAVALLIERATOS *et al.*, 2001) and in America (PIKE *et al.*, 1997; BREWER & ELLIOT, 2004; STARY *et al.*, 2007). The present study is a survey of the aphids and their parasitoids present in Oum El Bouaghi province (Algeria) as an example of a steppe area. The extension and domination of cultivated areas in the study province can alter natural landscapes and affect the composition and balance of various community interactions. The aim of the present contribution is to identify the Aphidiinae species richness attacking aphids feeding on plants as well as to provide supplementary information about alternative host plants, which may serve as reservoirs.

## Materials and methods

The province of Oum El Bouaghi is located in northeastern Algeria. It belongs to the highlands constrained by parallel chains of the Tell Atlas in the north and the Saharan Atlas in the south (Figure 1). It is a steppe area characterized by a semi-arid climate with cold and dry winters (<400-600 mm / year) and high temperatures in summer (30-36°C) (BENCHERIF, 2008).



**Figure 1.** Map of the sampling sites in Oum El Bouaghi (Algeria)  
*Carte des sites d'échantillonnage à Oum El Bouaghi (Algérie)*

Our study has focused on different natural and farming sites in five localities; Ain Zitoun station (846 m, 35°40'55"N, 6°55'43"E), Meskiana (856 m, 35°36'52"N,

7°38'59"E), Bir Khecheba (960 m, 35°53'39"N, 7°09'33"E), Kasr Sbihi (802 m, 36°05'28"N, 7°15'34"E) and Sidi Rghiss Montagne in Oum El Bouaghi center

(1023 m, 35°54'11"N, 7°07'29" E). All these localities depend on cereals as the main crops, and are watered by rain, and recently by well drilling. Intensive use of insecticides is observed in the protection of fruit tree crops, especially apple trees, and vegetables, especially melon species (BOUZIANE, 2022). There is also the prickly pear (*Opuntia ficus-indica*) (Cactaceae) crop. The forests are principally composed of Aleppo pine (*Pinus halepensis*) (Apiaceae), Holm oak (*Quercus ilex*) (Fagaceae), the Phoenician juniper (*Juniperus phoenicea*) and the cade juniper (*Juniperus oxycedrus*) (Cupressaceae), and, on limestone terrains, one finds jujube (*Ziziphus zizyphus*) (Rhamnaceae) (SCHEUCHLET *et al.*, 2011) and weed plants such as *Artemisia herba alba*, *Medicago sativa*, *Malva sylvestris*, *Sonchus oleraceus* and *Sonchus arvensis*.

Samples were collected during the period 2013-2016 according to the habitat types and the season of the year. All specimens were collected by sweeping the maximum number of plants in the sampled habitat (cultivated or natural) in each site. One to three samples were collected per month per site. These samples included host plants and host aphids with mummies. In order to detect the presence of aphid colonies, all parts of the host plants, including the leaves, stems, collar region, flowers and, when possible, roots were inspected. After aphids and aphid mummies were detected, they were collected and carefully placed in semi-transparent rearing plastic boxes. Aphids and any parasitoids that emerged were collected similarly and preserved in 70% ethanol for later identification. The host plants were labeled and herbarized for identification at a later date. Host associations are listed as follows: host aphid, host plant, locality and date (number and gender of specimens). The aphid parasitoids were identified using some keys such as STARY (1976) and KAVALLIERATOS *et al.* (2006).

## Results

### Bi-trophic associations Aphid-plant in Oum El Bouaghi province

The results of aphid species inventory in the different environments of the Oum El Bouaghi region reported in **Table 1** show that spring and autumn seasons are characterized by intense plant and aphid activity and the diversity of plants, aphids and parasitoids varies according to the habitats surveyed. The botanical diversity is represented by a set of 30 host plants, divided into 14 families. Among these families, the Asteraceae, Poaceae and Fabaceae are the richest in terms of species, with 6, 4 and 3 species, respectively.

In our case, aphids that colonize agricultural habitats are more represented than aphids in forest environments. Some aphid species, such as *Acyrtosiphum pisum*, *Aphis fabae*, *Rhopalosiphum maidis*, *Rhopalosiphum padi*, *Metopolophium dirhodum*, *Brachycaudus helichrysi* and *Hyperomyzus lactucae* were found on herbaceous crops. Others attacked woody crops (*Myzus persicae*, *Dysaphis plantaginea*,

*Hyalopterus pruni*, *Aphis pomi*, *Aphis craccivora* and *Aphis gossypii*). Other species like *Uroleucon jaceae*, *Uroleucon sonchi*, *Ovatomyzus chamaedrys*, *Brachyunguis harmalae*, *Aphis anthemiae*, *Aphis balloticola*, *Aphis rumicis*, *Aphis umbrella* or *Protaphis terricola* are specific to wild plants. According to the data collected, the Aphidinae sub-family with 17 genera, 32 species and 4 tribes has the highest number of species identified and the widest distribution compared to the Chaitophorinae sub-family with only one species and the Thelaxinae sub-family with only *Thelaxes suberi*, which was found on forest trees (**Table 1**).

### Tri-trophic associations aphid parasitoid hymenoptera – aphid - plant in Oum El Bouaghi province

Seven species of aphid parasitoids were identified in this study belonging to 6 genera (**Table 2**). The parasitoid host ranges of cultivated and wild plants are similar. Fourteen tri-trophic associations were formed by aphid parasitoids and the species *Lysiphlebus testaceipes* was able to parasitize 7 aphid species and forms 7 relationships, which represents 50 % of the total tri-trophic associations found. Identified parasitoid species are known to be generalist and the absence of specialist specimens is noted.

## Discussion

During recent years, increasing attention has been directed toward other forms of pest control than the use of chemical pesticides. The overall stability of an agroecosystem or a natural ecosystem is ensured by the diversity of insect parasitoids and predators of pests (TOMONOVIC *et al.*, 2005).

This inventory, with 34 aphid species identified, enriches the work on aphid diversity carried out in Algeria. About 170 aphid species have been described in Algeria by LAAMARI *et al.* (2010; 2011; 2012; 2013) and AIT AMAR & BENOUELLA KITOUS (2020). This recorded aphid fauna may infest cultivated crops and wild plants, but the latter obviously do not have the same economic importance. Some aphid species are very harmful to cultivated and/or forest plants, others only infest wild plants.

The results of bi-trophic aphid-plant relationships show that the most polyphagous aphid species are *Aphis craccivora*, *Aphis fabae* and *Brachycaudus helichrysi* with three host plants each, and *Aphis gossypii*, *Aphis pomi*, *Myzus persicae* and *Rhopalosiphum padi* with two host plants each. The remaining aphid species were found on only one host plant species. All the aphid species found in the present study had already been reported in the neighboring provinces of Khanchela and Batna (LAAMARI *et al.*, 2011), with the exceptions of *Aphis anthemiae* and *Ovatomyzus chamaedrys* which were detected for the first time in Algeria in association with *Anthemis tomentosa* and *Scabiosa crenata*, respectively.

**Table 1:** Diversity of bi-trophic relationships (plant-aphid) in the Oum El Bouaghi region (PART 1)  
Diversité des relations bi-trophiques (plante – puceron) dans la région d'Oum El Bouaghi

Family	Sub-family	Tribes	Species	Host plants	Botanical families	Sampling sites	Sampling dates
Aphididae	Aphidinae	Aphidini	<i>Aphis anthemiae</i> (Ivanovskaya, 1960)	<i>Anthemis tomentosa</i>	Asteraceae	Ain Zitoun U	28-05-2015
			<i>Aphis balloticala</i> (Szelegiewicz, 1968)	<i>Marrubium vulgare</i>	Lamiaceae	Bir Khecheba C	11-02-2013 01-10-2013
			<i>Aphis confusa</i> (Walker, 1849)	<i>Scabiosa atropurpurea</i>	Caprifoliaceae	Bir Khecheba U	25-04-2014
			<i>Aphis craccivora</i> (Koch, 1854)	<i>Calycotome spinosa</i> <i>Peganum harmala</i> <i>Medicago arborea</i>	Fabaceae Nitraryaceae Fabaceae	Sidi R'ghiss U Sidi R'ghiss U Bir Khecheba C	07-08-2014 08-05-2014 31-05-2015
			<i>Aphis fabae</i> (Scopoli, 1763)	<i>Scabiosa atropurpurea</i> <i>Vicia faba</i> <i>Solanum tuberosum</i>	Caprifoliaceae Fabaceae Solanaceae	Bir Khecheba U Bir Khecheba C Bir Khecheba C	25-04-2014 23-10-2013 11-05-2013
			<i>Aphis gossypii</i> (Glover, 1877)	<i>Cucurbita pepo</i> <i>Cucumis melo</i>	Cucurbitaceae Cucurbitaceae	Ain Zitoun C Ain Zitoun C	26-03-2015 15-10-2016 23-10-2015
			<i>Aphis pomi</i> (De Geer, 1773)	<i>Prunus armeniaca</i> <i>Malus domestica</i>	Rosaceae Rosaceae	Bir Khecheba C Kasr-Sbihi C	17-05-2013 01-05-2014
			<i>Aphis punicae</i> (Passerini, 1863)	<i>Punica granatum</i>	Lythraceae	Bir Khecheba C Ain Zitoun C	04-05-2013 09-05-2016 05-06-2015 19-10-2015
			<i>Aphis rumicis</i> (Linnaeus, 1758)	<i>Rumex crispus</i>	Polygonaceae	Bir Khecheba C	24-04-2014
			<i>Aphis umbrellae</i> (Borner, 1950)	<i>Malva sylvestris</i>	Malvaceae	Bir Khecheba C Ain Zitoun C	16-11-1013 29-10-2015 20-04-2016
			<i>Hyalopterus amygdali</i> (Blanchard, 1840)	<i>Phragmites communis</i>	Poaceae	Bir Khecheba C	28-05-2013
			<i>Hyalopterus pruni</i> (Geoffroy, 1762)	<i>Prunus armeniaca</i>	Rosaceae	Bir Khecheba C	13- 05-2013
			<i>Rhopalosiphum maidis</i> (Fich, 1856)	<i>Triticum durum</i>	Poaceae	Bir Khecheba C	11-05-2013 28-05-2015 27-04-2016
			<i>Rhopalosiphum padi</i> (Linnaeus, 1758)	<i>Triticum durum</i> <i>Hordeum murinum</i>	Poaceae Poaceae	Ain Zitoun C Ain Zitoun C	11-05-2013 28-05-2015
			<i>Rhopalosiphum rufiabdominale</i> (Sasaki, 1899)	<i>Solanum tuberosum</i>	Solanaceae	Bir Khecheba C	11-05-2013
			<i>Protaphis terricola</i> (Rodani, 1847)	<i>Mantisalca salmantica</i>	Asteraceae	Bir Khecheba C	24-05-2013 28-04-2014

**Table 1:** Diversity of bi-trophic relationships (plant-aphid) in the Oum El Bouaghi region (PART 2)  
Diversité des relations bi-trophiques (plante – puceron) dans la région d'Oum El Bouaghi

Family	Sub-family	Tribes	Species	Host plants	Botanical families	Sampling sites	Sampling dates
Aphididae	Aphidiinae	Macrosiphini	<i>Acyrtosiphon gossypii</i> (Mordvilko, 1914)	<i>Malva sylvestris</i>	Malvaceae	Bir Khecheba C Ain Zitoun C	23-05-2013 20-04-2016
			<i>Acyrtosiphum pisum</i> (Harris, 1776)	<i>Vicia sativa</i>	Fabaceae	Ain Zitoun C	28-05-2015
			<i>Aulacorthum solani</i> (Kaltenbach, 1843)	<i>Daucus carota</i>	Apiaceae	Bir Khecheba C	28-04-2013
			<i>Brachycaudus cardui</i> (Linnaeus, 1758)	<i>Peganum harmala</i>	Nitriariaceae	Sidi R'ghiss U Ain Zitoun C	08-05-2014 20-04-2016
			<i>Brachycaudus helichrysi</i> (Kaltenbach, 1843)	<i>Anacyclus clavatus</i> <i>Foeniculum vulgare</i> <i>Pullenis spinosa</i>	Asteraceae Apiaceae Asteraceae	Bir Khecheba C Ain Zitoun C Sidi R'ghiss U	28-04-2014 05-05-2015 07-05-2014
			<i>Brachyunguis harmalae</i> (Das, 1918)	<i>Peganum harmala</i>	Nitriariaceae	Ain Zitoun C	25-05-2015
			<i>Dysaphis plantaginea</i> (Passerini, 1860)	<i>Malus domestica</i>	Rosaceae	Ain Zitoun C	11-05-2013 25-05-2015 05-06-2015 23-04-2016
			<i>Hyperomyzus lactucae</i> (Linnaeus, 1758)	<i>Hordeum vulgare</i>	Poaceae	Bir Khecheba C	13-05-2013
			<i>Macrosiphum euphorbiae</i> (Thomas, 1878)	<i>Hertia cheirifolia</i>	Asteraceae	Bir Khecheba C	28-04-2014
			<i>Macrosiphum rosae</i> (Linnaeus, 1758)	<i>Scabiosa atropurpurea</i>	Caprifoliaceae	Bir Khecheba U	25-04-2014
			<i>Metopolophium dirhodum</i> (Walker, 1849)	<i>Hordeum vulgare</i>	Poaceae	Bir Khecheba C	13-05-2013
			<i>Myzus persicae</i> (Sulzer, 1776)	<i>Malus domestica</i> <i>Prunus armeniaca</i>	Rosaceae Rosaceae	Meskiana C Kasr-Sbihi C	09-06-2013 01-05-2014
			<i>Ovatomyzus chamaedrys</i> (Passerini, 1879)	<i>Scabiosa crenata</i>	Caprifoliaceae	Ain Zitoun C	28-06-2015
			<i>Sitobion fragariae</i> (Walker, 1848)	<i>Hordeum murinum</i>	Poaceae	Bir Khecheba C	28-04-2014
			<i>Uroleucon jaceae</i> (Linnaeus, 1758)	<i>Carthamus lanatus</i>	Asteraceae	Bir Khecheba C	29-04-2014
			<i>Uroleucon sonchi</i> (Linnaeus, 1767)	<i>Sonchus asper</i>	Asteraceae	Bir Khecheba C	28-10-2013
			<i>Sipha maydis</i> (Passerini, 1860)	<i>Stipa tenacissima</i>	Poaceae	Bir Khecheba U	28-04-2014
			<i>Thelexes suberi</i> (Del Guercio, 1911)	<i>Quercus ilex</i>	Fagaceae	Bir Khecheba U	23-09-2013 07-01-2014 27-04-2016

C: cultivated habitat U: uncultivated habitat

**Table 2:** Diversity of tri-trophic relationships (plant-aphid-parasitoid) in the Oum El Bouaghi region  
*Diversité des relations tri-trophiques (plante – puceron- parasitoïdes dans la région d'Oum El Bouaghi*

Family	Sub-family	Parasitoid species	Aphid hosts	Plant hosts and location/date	Number of individuals affected
Braconidae	Aphidiidae	<i>Aphidius ervi</i> (Haliday, 1834)	<i>Hyalopterus amygdali</i>	<i>Phragmites communis</i> Bir Khecheba: 28-05-2013	2
		<i>Binodoxys angelicae</i> (Haliday, 1833)	<i>Aphis balloticola</i>	<i>Marrubium vulgare</i> Bir Khecheba: 02-12-2013	2
		<i>Diaeretiella rapae</i> (M'intosh, 1855)	<i>Aphis pomi</i>	<i>Prunus armeniaca</i> Bir Khecheba: 29-05-2013	4
			<i>Rhopalosiphum padi</i>	<i>Hordeum murinum</i> Ain Zitoun: 28-04-2015	5
		<i>Ephedrus persicae</i> (Froggat, 1904)	<i>Aphis pomi</i>	<i>Prunus armeniaca</i> Bir Khecheba: 29-05-2013	1
		<i>Lysiphlebus fabarum</i> (Marchall, 1836)	<i>Aphis balloticola</i>	<i>Marrubium vulgare</i> Bir Khecheba: 02-12-2013	2
		<i>Lysiphlebus testaceipes</i> (Cresson, 1880)	<i>Aphis pomi</i>	<i>Prunus armeniaca</i> Bir Khecheba: 29-05-2013	3
			<i>Dysaphis plantaginea</i>	<i>Malus domestica</i> Meskiana: 05-06-2013 Kasr Sbihi: 10-05-2014	2 19
			<i>Aphis punicae</i>	<i>Punica granatum</i> Bir Khecheba 18-05-2013	2
			<i>Aphis balloticola</i>	<i>Marrubium vulgare</i> Bir Khecheba 18-12-2013	2
			<i>Brachynguis harmalae</i>	<i>Peganum harmala</i> Bir Khecheba:18-05-2013	2
<i>Aphis fabae</i>	<i>Vicia faba</i> Bir Khecheba: 02-11-1013		6		
<i>Praonvolucre</i> (Halidy, 1833)	<i>Aphis balloticola</i>	<i>Marrubium vulgare</i> Bir Khecheba: 02-12-2013	21		
	<b>TOTAL</b>	<b>7</b>	<b>8</b>	<b>8</b>	<b>77</b>

There are 11 species of specialist or monophagous aphids whose feeding was found to be restricted to a single plant, including *Thelaxes suberi*, which feeds on holm-oak trees and 10 species which feed on wild plants. On members of the Poaceae family, we detected three species (*Rhopalosiphum maidis*, *R. padi* and *Metopolophium dirhodum*) on cereal crops and *Sipha maydis* and *Sitobion fragariae* on wild Poaceae. Note that a few native steppe plants species show reduced aphid abundance, and the majority of those plants is not infested by aphids (LESCANO & FARJI-BRENER, 2011).

In Algeria, more than 29 aphid parasitoid species were known (GHELAMALLAH *et al.*, 2018). In neighboring Oum El Bouaghi as Khenchela province, 13 parasitoid species have been reported in the natural environment (AGGOUN, 2016) and studies that have focused on Algerian arid regions such as the study by TAHAR CHAOUICHE & LAAMARI (2015) and CHEHMA & LAAMARI (2014), recorded the presence of 14 species of parasitoids in Biskra and 15 species of parasitoids in Ghardaia. Twelve species were identified in Mostaganem (north-west Algeria) with a new species for Algeria: *Aphidius platensis* by GHELAMALLAH *et al.* (2018). In the present study region, there was only one study that detected the presence of five aphid parasitoid species: *Aphidius matricariae*, *Aphidius rhopalosiphi*, *Aphidius*

*uzbekistanicus*, *Diaeretiella rapae* and *Lysiphlebus testaceipes* on the aphids *Rhopalosiphum maidis*, *Diuraphis noxia* and *Sitobion fragariae* feeding on cereal crops (MEROUANI, 2010). Our results are richer in species breadth but confirm the five species found previously belonging to the Braconidae family and Aphidiidae sub-family. All genera of aphid parasitoids that have been found in Algeria are present in this inventory but, at the species level, these results are poorer when compared to previous studies.

Among the 14 tri-trophic relationships, the parasitoid species *Lysiphlebus testaceipes* ranked first in terms of abundance and host range and most of its hosts were fruit tree aphids (*Aphis pomi* on *Prunus armeniaca*, *Dysaphis plantaginea* on *Malus communis* and *Aphis punicae* on *Punica granatum*). Also, it was associated with a single species of cereal aphid, *Rhopalosiphum padi*. The *Aphidius* genus is represented by a single species, *Aphidius ervi*, collected from mummies of *Hyalopterus amygdali* on *Phragmites communis*. According to LAAMARI *et al.* (2011), this parasitoid is recorded on 13 aphid species in the eastern region of Algeria. STARY (1973) reported that it is very common on cereal aphids.

*Diaeretiella rapae* is a polyphagous parasitoid with two tri-trophic associations, with *Aphis pomi* on *Prunus armeniaca* and *Rhopalosiphum padi* on *Hordeum*



*murinum*. The study of AROUN (2015) shows also that *D. rapae* can parasitize a wide range of hosts, but with a preference for cereal and brassica aphid species.

*Lysiphlebus fabarum*, which is known for its efficiency against *Aphis fabae* and *Aphis craccivora* (STARY *et al.*, 2000; RAKHSHANI *et al.*, 2005a, b), is known as a generalist parasitoid (STARY, 1979), recorded on 140 aphid species belonging to 36 genera, of which 81 species belong to the genus *Aphis*. In this study, it was identified for the first time in Algeria as a parasitoid of *Aphis balloticola* on *Marrubium vulgare*.

The parasitoid species *Praon volucre*, *Ephedrus persicae* and *Binodoxys angelicae* showed throughout this study a limited efficiency, despite their known and confirmed character as polyphagous parasitoids. On the other hand, the lack of parasitoid activity on *Aphis gossypii* on Cucurbitaceae crops may be related to the sensitivity of the parasitoids to high summer temperatures or to the effect of insecticides. According to AROUN (2015), *A. gossypii* on Cucurbitaceae in the coastal region was attacked by 4 parasitoid species (*Ephedrus persicae*, *Aphidius matricariae*, *Lysiphlebus fabarum* and *Ephedrus plagiator*).

In our case, the wild species *Marrubium vulgare* and *Peganum harmala* were the only wild plant species that associated with parasitoid activity on aphids. Moreover, *Malva sylvestris*, *Sonchus asper* and *Mantisalca salmantica* did not present any tri-trophic associations with aphid parasitoids, although there are three listed wild species which can attract many species of parasitoids in other regions in East Algeria (LAAMARI *et al.*, 2012).

## Conclusions

The present study, carried out in different habitats in the province of Oum El Bouaghi (Algeria) during the period 2013-2016, has revealed the presence of 34 aphid species related to 30 host plant species. Seven aphid parasitoid species were found and they have formed 14 tri-trophic relationships (parasitoid – aphid – plant). *Lysiphlebus testaceipes* parasitoid species was able to parasitize seven aphid species, such as *Aphis pomi*, *Aphis plantaginea* and *Aphis fabae*, which make it the first candidate for biological control against this species of aphids in this region. General comparison of the data with neighboring regions shows that poor biodiversity of the Aphidiinae has been detected in Oum El Bouaghi.

However, habitats in various parts of Oum El Bouaghi province have not been visited in detail so far. It is likely that with further research, the number of species present in the area will increase and it is expected that more species will be detected.

## References

ABD ESSEMED, D.F. (1998).- *Complément d'inventaire des hyménoptères Aphidiides et contribution à l'étude biologique de Diaeretiella rapae M'int.*

(Hyménoptères: Aphidiidae) parasite du puceron cendré du chou *Brevicoryne brassicae* L., et du puceron vert de pêcher *Myzus persicae* Sulz. (Homoptera: Aphididae). Mémoire d'ingénieur Agronomique. Université de Blida, Algérie, 109 p.

AGGOUN, H. (2016).- *Contribution à l'étude des Hyménoptères parasitoïdes des pucerons associés au milieu naturel dans la région de Khenchela*. Thèse de Magister en Agronomie. Univ. Batna, 61 p.

AIT AMAR, S. & BENOUEFELLA-KITOUS, K. (2020).- Diversity of aphids (Hemiptera: Aphididae) associated with potato crop in Tizi-Ouzou (North of Algeria), with new records. *Acta. Agr. Slovenica.*, **117** (1), 1-9.

AROUN, M. (2015).- *Le complexe aphides et ennemis naturels en milieux cultivé et forestier en Algérie*. Thèse de doctorat en Agronomie, Univ. Alger, 148 p.

BENCHERIF, L. (2008).- *Les indices climatiques et leurs significations écologiques en Algérie orientale*. Mémoire de Magister en sciences naturelles Université de Constantine, 140 p.

BLACKMAN, R.L. & EASTOP, V.F. (2000).- *Aphids on the world's crops: An identification and information guide*. Ed. John Wiley & Sons (UK), 466 p.

BOIVIN, G., HANCE, T. & BRODEUR, J. (2012).- Aphid parasitoids in biological control. *Can J. Sci.*, **92**, 1-12.

BOUZIANE, B. (2022).- *Evaluation du taux de résidus des pesticides au niveau de l'ITCMI (sol et eaux des puits) afin d'étudier leur impact et incidence sur la qualité de l'environnement*. Mémoire de Master en chimie. Université Larbi Ben M'hidi d'Oum El Bouaghi, Algérie, 230 p.

BREWER, M.J & ELLIOT, N.C. (2004).- Biological control of cereal Aphids in North America and mediating effect of host plant and habitat manipulations. *Ann. Rev. Entomol.*, **49**, 219-242.

CHEHMA, S. & LAAMARI, M. (2014).- Etude bioécologique des hyménoptères parasitoïdes des pucerons associés au milieu naturel et cultivés dans la région de Ghardaia. *Rev. Bio Ressources*, **4** (2), 62-75.

GHELAMALLAH, A., RAKHSHANIE, A., BOUHRAOUA, R., MISHELENA, J.M., BOUALEM, M., FERRER-SUAY, M. & PUJADE-VILLAR, J. (2018).- New Hymenoptera records (Braconidae: Aphidiinae) from Algeria and the Northern Africa, and notes about other species. *Entomofauna*, **13**, 301-316.

HANSON, A.A., MENDER-ANDERSON, J., SILVERSTEINIL, C., POTTER, B.D., MACRAE, I.V., HODGSON, E.W. & KOCH, R.L. (2017).- Evidence for Soybean Aphid (Hemiptera: Aphididae) Resistance to Pyrethroid Insecticides in the Upper Midwestern United States. *J. Econ. Entomol.*, **110** (5), 2235–2246.

KAVALLIERATOS, N.G., LYKOURESSIS, D.P., SARLIS, G.P., STATHAS, G.J., SANCHIS SEGOVLA, A. & ATHANASSIOU, C.G. (2001).- The Aphidiinae (Hymenoptera: Ichneumonoidea) of Greece. *Phytoparasitica*, **29** (4), 306-340.

KAVALLIERATOS, N.G., TOMONOVIC, Z., STARY, P., ATHANASSIOU, C.G., SARLIS, G.P., PETROVIC, O.,

- NIKETIČ, M. & VERONIKI, M.A. (2004).- A survey of aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) of Southeastern Europe and their aphid-plant associations. *Appl. Entomol. Zool.*, **39** (3), 527-563.
- KAVALLIERATOS, N.G., TOMONOVIČ, Z., STARÝ, P. & BOGDANOVIČ, A.M. (2008).- Parasitoids (Hymenoptera: Braconidae: Aphidiinae) attacking aphids feeding on Prunoideae and Maloideae crops in southeast Europe: aphidinae – aphid - plant associations and key. *Zootaxa*, **1793** (1), 47-64.
- LAAMARI, M., JOSSELIN, E. & COEUR D'ACIER, A. (2010).- Assessment of aphid diversity (Hemiptera: Aphididae) in Algeria: a fourteen-year investigation. *Faun. Entomol.*, **62**, 3-87.
- LAAMARI, M., TAHAR CHAOUICHE, S., BENFARHAT, S., ABBES, S.B., MEROUANI, H. & GODBENE, E.S. (2011).- Interactions tri-trophiques: plante-puceron-hyménoptère parasitoïde observées en milieux naturels et cultivés de l'Est algérien. *Faun. Entomol.*, **63** (3), 115-120.
- LAAMARI, M., TAHAR CHAOUICHE, S., HALIMI, C.W., BENFARHAT, S., ABBES, S.B. & KHENISSA, N. (2012).- A review of Aphid parasitoids and their associations in Algeria( hymenoptera: Aphidiinae: Hemiptera :Aphidoidea). *African Entomology*, **20** (1), 161-170.
- LAAMARI, M., CŒUR D'ACIER, A. & JOUSSELIN, E. (2013).- New data on aphidfauna (Hemiptera, Aphididae) in Algeria. *ZooKeys*, **319**, 223-229.
- LESCANO, M.N. & FARJI-BRENER, A.G. (2011).- Exotic thistles native and abundance through the maintenance of enhanced aphid populations. *Ecol. Res*, **26**, 827-834.
- MEROUANI, H. (2009).- *Etude écologique des hyménoptères parasitoïdes des pucerons des céréales dans la région de Ain Kercha (Wilaya d'Oum ElBouaghi)*. Mémoire d'ingénieur Agronomique. Université de Batna, 38 p.
- PIKE, K.S., STARY, P., MILER, T., ALLISON, D, BODYSTON, L., GRAF, G. & GILLESPIE, R. (1997).- Small-grain aphid parasitoids (Aphelinidae and Aphidiidae) of Washington: distribution, relative abundance, seasonal occurrence, and key to know North America. *Environ. Entomol.*, **26** (6), 1299-1311.
- RAKHSHANI, E., TALEBI, A.A., KAVALLIERATOS, N.G., REZWANI, A., MANZARI, S. & TOMONOVIČ, Z. (2005a).- Parasitoid complex (Hymenoptera, Braconidae, Aphidiinae) of *Aphis craccivora* Koch (Hemiptera: Aphidoidea) in Iran. *J. Pest Sci.*, **78**, 193-198.
- RAKHSHANI, E., TALEBI, A.A., STARY, P., MANZARI, S. & REZWANI, A. (2005b).- Re-description and Biocontrol Information of *Pauesia antennata* (Mukerji) (Hym., Braconidae, Aphidiinae) parasitoid of *Pterochloroides persicae* (Chol.) (Hom., Aphidoidea, Lachnidae). *J. Ent. Res. Soc.*, **7** (3), 59-69.
- RUBERSON, J.R. (1999).- *Handbook of Pest Management*. Marcel Dekker Inc., New York.
- SCHEUCHL, E., BENARFA, N. & LOUADI, K. (2011).- Description of new *Andrena* (Hymenoptera; Apoidea; Andrenidae). *Entomofauna.*, **12**, 221-232.
- STARY, P., REMAUDIERE, G. & LECLANT, F. (1973).- Nouvelles données sur les Aphidiides de France (Hym). *Ann. Soc. Entomol., Fr.*, (N.S), **9** (2), 309-329.
- STARY, P. (1976).- *Aphid parasites (Hymenoptera: Aphidiidae) of the Mediterranean area*. Dr W. Junk, The Hague, Netherlands, 95 p.
- STARY, P. (1979).- *Aphid Parasites (Hymenoptera: Aphidiidae) of the Central Asian Area*. Dr. W. Junk b.v., The Hague/Academia, Prague.
- STARY, P. (1988).-Aphidiidae. In: Van Emden, H.F & Harrington, R. (1988).- *World Crop Pests, Aphids, their biology, natural enemies and control*. Elsevier, (Eds. A.K. Minks and P. Harrewijn), Amsterdam, 2B: **364**, 171-184.
- STARY, P., GERDING, M., NORAMBUENA, H. & REMAUDIERE, G. (1993).- Environmental research on aphid parasitoid biocontrol agents in Chile (Hym., Aphidiidae; Hom., Aphidoidea). *J. Appl. Entomol.*, **115**, 292-306.
- STARY, P., REMAUDIERE, G., GONZALEZ, D. & SHAHROKHI, S. (2000).- A review and host associations of aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) of Iran. *Parasitica*, **56** (1), 15-41.
- STARY, P., SAMPIO, M.V. & PAES BUENO, V.H. (2007).- Aphid parasitoids (Hymenoptera, Braconidae, Aphidiinae) and their associations related to biological control in Brazil. *Rev. Bras. Entomol.*, **51** (1), 107-108.
- TAHAR-CHAOUICHE, S. & LAAMARI, M. (2015).- Aphid parasitoid species (Hymenoptera: Braconidae: Aphidiinae) and their associations in Biskra province, Algeria. *J. Entomol. Zool. St.*, **3** (2), 179-184.
- TOMONOVIČ, Ž., STARY, P, KAVALLIERATOS, N.G., GAGIČ, V., PLEČAS, M., JANCOVIČ, M., RAKHSHANI, E., ČETKOVIČ, A. & PETROVIČ, A. (2012).- Aphid parasitoids (Hymenoptera; Braconidae: Aphidiinae) in wetland habitats in western Palearctic: key and associated aphid parasitoid guilds. *Ann. Soc. Entomol. Fr.*, **48** (1-2), 189-198.
- VAN LENTREN, C.J., BALLE, J., BIGLER, F., HOKKENEN, H. & LOOMANS, A.J.M. (2006).- Assessing risks of releasing exotic biological control agents of arthropod pests. *Ann. Rev. Entomol.*, **51**, 609-634.