

First record of *Coccinella septempunctata algerica* (Coleoptera, Coccinellidae) as a host of *Dinocampus coccinellae* (Hymenoptera, Braconidae, Euphorinae) in Algeria

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Abstract

First record of Coccinella septempunctata algerica (Coleoptera, Coccinellidae) as host of Dinocampus coccinellae (Hymenoptera, Braconidae, Euphorinae) in Algeria. This study was conducted in fields in the Boumerdes region near Algiers, Algeria between April and September 2019. Two species of Coccinellini, *Coccinella septempunctata algerica* (Kovàr, 1977) and *Hippodamia variegata* (Goeze, 1777) were recorded as hosts of the parasitoid *Dinocampus coccinellae* (Schrank, 1802). The percentage of parasitism observed during the sampling was low. Our results suggest that *D. coccinellae* is not well adapted to *Harmonia axyridis* (Pallas, 1773). This work shows that the parasitoid has a greater preference for *C. septempunctata algerica* than for *H. variegata* (16.7% versus 2.2% of parasitism). Given the low percentage of parasitism due to *D. coccinellae*, it does not seem that this parasitoid is able to reduce the effectiveness of biocontrol by ladybeetles. This is the first published record of *Dinocampus coccinellae* as a parasitoid of *C. septempunctata algerica* in Algeria.

Key words: *Dinocampus coccinellae*, *Coccinella septempunctata algerica*, *Hippodamia variegata*, Parasitoid, Parasitism rate

Resumen

Primer registro de Coccinella septempunctata algerica (Coleoptera, Coccinellidae) como huésped de Dinocampus coccinellae (Hymenoptera, Braconidae, Euphorinae) en Argelia. Este estudio se desarrolló en campos situados en la región de Boumerdes, próxima a Argel (Argelia), entre los meses de abril y septiembre de 2019. Se registraron dos especies de Coccinellini, *Coccinella septempunctata algerica* (Kovàr, 1977) e *Hippodamia variegata* (Goeze, 1777), como huéspedes del parasitoide *Dinocampus coccinellae* (Schrank, 1802). El porcentaje de parasitismo observado durante el muestreo fue bajo. Nuestros resultados sugieren que *D. coccinellae* no está bien adaptado a *Harmonia axyridis* (Pallas, 1773). Este trabajo muestra que el parasitoide tiene mayor predilección por *C. septempunctata algerica* que por *H. variegata* (16,7% frente a 2,2% de parasitismo). Dado el bajo porcentaje de

parasitismo por *D. coccinellae*, no parece que este parasitoide pueda reducir la eficacia del biocontrol mediante mariquitas. Este es el primer registro publicado de *Dinocampus coccinellae* como parasitoide de *C. septempunctata algerica* en Argelia.

Palabras clave: *Dinocampus coccinellae*, *Coccinella septempunctata algerica*, *Hippodamia variegata*, parasitoide, tasa de parasitismo

Resum

Primer registre de *Coccinella septempunctata algerica* (Coleoptera, Coccinellidae) com a hoste de *Dinocampus coccinellae* (Hymenoptera, Braconidae, Euphorinae) a Algèria. Aquest estudi es va portar a terme en camps situats a la regió de Boumerdes, prop d'Alger (Algèria), entre els mesos d'abril i setembre de 2019. Es van registrar dues espècies de Coccinellini, *Coccinella septempunctata algerica* (Kovàr, 1977) i *Hippodamia variegata* (Goeze, 1777), com a hostes del parasitoide *Dinocampus coccinellae* (Schrank, 1802). El percentatge de parasitisme observat durant el mostreig va ser baix. Els nostres resultats suggereixen que *D. coccinellae* no està ben adaptat a *Harmonia axyridis* (Pallas, 1773). Aquest treball mostra que el parasitoide té més predilecció per *C. septempunctata algerica* que per *H. variegata* (16,7 % i 2,2 % de parasitisme). Atès el baix percentatge de parasitisme per *D. coccinellae*, no sembla que aquest parasitoide pugui reduir l'eficàcia del biocontrol mitjançant marietes. Aquest és el primer registre publicat de *Dinocampus coccinellae* com a parasitoide de *C. septempunctata algerica* a Algèria.

Paraules clau: *Dinocampus coccinellae*, *Coccinella septempunctata algerica*, *Hippodamia variegata*, Parasitoide, Taxa de parasitisme

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Introduction

Ladybeetles are of great economic importance as they feed on several potential pests, thus controlling populations in many agricultural systems. They intervene both in larval and adult stages (Dixon, 2000; Isikber and Copland, 2002; Lundgren, 2009; Obrycki et al., 2009). The bioecology of ladybeetles has been well documented in Algeria, especially in the work of Saharaoui (1987, 1994) and Sharaoui et al. (2001). These species may be subject to the action of one or more species of natural enemies, such as *Dinocampus coccinellae*. The biology of this parasitoid has been well documented by Obrycki (1989), Majerus et al. (2000), Firliej et al. (2005), Berkvens et al. (2010), Maure et al. (2011), Silva et al. (2012), Koyama et al. (2013), Minaar et al. (2014), Dindo et al. (2016), Ceryngier et al. (2018), and Maqbool et al. (2018). Studies concerning the natural enemies of Coccinellidae and *Dinocampus coccinellae* in Algeria, however, are rare, and studies to date only report their presence. *Dinocampus coccinellae* is a parasitoid of another ladybeetle species, *Hippodamia variegata* (Saharaoui, 1994). This braconidae is a solitary endoparasitoid that exclusively parasitizes Coccinellid species (Firliej et al., 2005; Berkvens et al., 2010; Minaar et al., 2014). It reproduces by thelytokous parthenogenesis (Okuda and Ceryngier, 2000; Riddick et al., 2009). Only one larva will develop inside the host even if the host has been parasitized several times (Ceryngier et al., 2012). Once it emerges from the host, the larva spins a

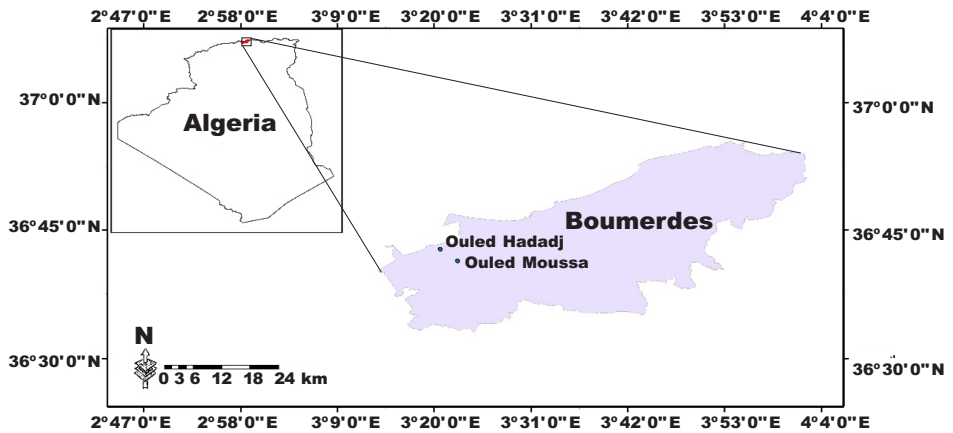


Fig. 1. Location of the collection site of Coccinellidae species, Boumerdes (Algeria).

Fig. 1. Localización del punto de recolección de especies de Coccinellidae, Boumerdes (Argelia).

cocoon between the legs of the host (Davis et al., 2006; Maure et al., 2011). The ladybee-
 tle remains partially paralyzed throughout the parasitoid pupal stage (Maure et al., 2011).
 The host usually dies afterwards (Dheilly et al., 2015). The rate of ladybeetle parasitism by
D. coccinellae can fluctuate significantly depending on location, season, and host species
 (Maure et al., 2016). The objective of this work was to study host–parasitoid relationships
 between *D. coccinellae* and the two–coccinellid species, *C. septempunctata algerica* and
H. variegata, parasitism rates in the field and in the laboratory.

Material and methods

Field survey

Samples of *C. septempunctata algerica*, *Psyllobora vingintiduopunctata*, *Harmonia axyridis*
 and *Hippodamia variegata* were collected over two–hour periods every 15 days from April
 to September 2019. Sampling was conducted on cultivated plants (*Zea mays*, *Phaseolus*
vulgaris, *Solanum tuberosum*) and weeds around fields (*Leucanthemum vulgare*, *Daucus carota*,
Malva sylvestris, *Galactites tomentosa*, *Galium aparine*, *Lysimachia foemina*). The beetles
 were collected by hand at two stations: Ouled Hadadj and Ouled Moussa in the Bou-
 merdes region (36° 45' 37.23' N, 3° 28' 20.52" E) (fig. 1). The collected ladybeetles
 were placed in plastic boxes (26 cm x 18 cm x 2 cm), kept at 22°C with a photoperiod of
 14 h of light and 10 h of darkness, and fed with aphids taken from *Daucus carota*, in order
 to check for the possible emergence of parasitoids. The emergence of parasitoids was
 recorded daily for 20 days.

Table 1. Monthly field data of parasitism of *Coccinella septempunctata algerica* and *Hippodamia variegata* by *Dinocampus coccinellae*: Nh, number of hosts; ND, number of *D. coccinellae*; Pr, parasitism rate.

Table 1. Datos mensuales de campo del parasitismo de *Coccinella septempunctata algerica* y *Hippodamia variegata* por *Dinocampus coccinellae*: Nh, número de huéspedes; ND, número de *D. coccinellae*; Pr, tasa de parasitismo.

	<i>C. septempunctata algerica</i>			<i>H. variegata</i>		
	Nh	ND	Pr	Nh	ND	Pr
April	42	2	4.76%	20	0	0%
May	55	8	14.55%	33	1	3.03%
June	64	13	20.31%	30	2	6.67%
July	54	3	5.56%	23	0	0%
August	32	3	9.38%	14	0	0%
September	30	1	3.33%	19	0	0%
Totals	277	30	10.83%	139	3	2.16%

Laboratory experiment

Each parasitoid that emerged from field-collected ladybeetles was placed in a Petri dish of 10 cm diameter and 1 cm in height. The non-parasitized adult ladybeetles collected in the field were placed in plastic boxes. Every 10 days, for three months, 10 individuals of *Coccinella septempunctata algerica* and 10 of *H. variegata* were placed in separate petri dishes. In each petri dish, we placed three individuals of *D. coccinellae*. Three individuals of *Psyllobora vingintiduopunctata* and *Harmonia axyridis* were placed in separate petri dishes, each with one parasitoid. The parasites used in this experiment were those collected directly in the field or taken from the ladybeetles collected. Behavior of some ladybeetles in the following days indicated they were parasitized. These parasitized ladybeetles were installed alone in a Petri dish and left for three weeks for observation and to verify the emergence of the parasitoid. The biological aspects of *D. coccinellae* were monitored in the laboratory at 24°C. The results were evaluated in terms of number and percentages of successfully parasitized ladybeetles (parasitism rate) (i.e. ladybeetles that produced a cocoon and adult parasitoid/number of ladybeetles exposed). The time (in days) was calculated: from the exposure of the hosts to the detection of the parasitoid cocoons; and from the detection of the cocoon to the emergence of the adult (duration of the pupal stage).

Results

Field survey

A total of 476 ladybeetles were collected. *C. septempunctata algerica* and *H. variegata* were the most abundant, with 416 individuals found on *Daucus carota*. Thirty-three *D. coccinellae* emerged from the adults (table 1). Adult ladybeetles were parasitized from April, reaching a maximum of parasitism in June. Rates of parasitoid emergence were 20.3% (n = 64)

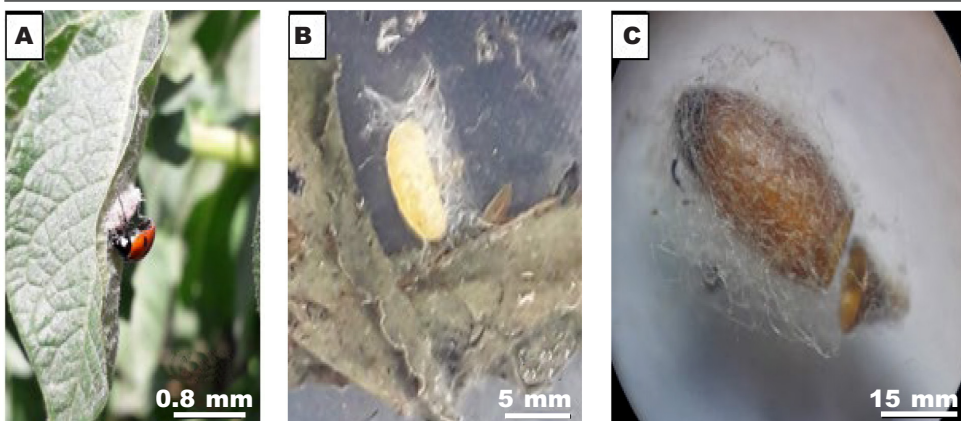


Fig. 2. A, adult of *C. septempunctata algerica* with cocoon of *D. coccinellae* on *Solanum tuberosum*; B, larva of *D. coccinellae*; C, cocoon of *D. coccinellae* after the emergence of adult wasp.

Fig. 2. A, adulto de *C. septempunctata algerica* con capullo de *D. coccinellae* en *Solanum tuberosum*; B, Larva de *D. coccinellae*; C, capullo de *D. coccinellae* después de la emergencia del coleóptero adulto.

for *C. septempunctata algerica* and 6.7% for *H. variegata*. No parasitism was recorded in *P. vingintiduopunctata* or *H. axyridis*. All the field-collected ladybeetles from which *D. coccinellae* emerged in the laboratory were females. This was verified by examining the genitalia of all parasitized individuals with an optical microscope.

Laboratory experiment

Dinocampus coccinellae emerged from 15 of 90 (16.7%) laboratory parasitized adults of *C. septempunctata algerica* and from two of 90 (2.2%) adults of *H. variegata*. Each parasitoid larva leaving its host pupated inside a cocoon spun between the host's legs and then emerged as an adult wasp (fig. 2). We observed that all parasitized ladybeetles died after the emergence of the parasitoid except for two individuals that remained alive but were not active. No parasitoid emerged from *Psyllobora vingintiduopunctata* or *Harmonia axyridis*. Figure 3 summarizes the life-cycle of the parasitoid and the duration of each stage of development (from host exposure to the emergence of adult wasp). We observed that *D. coccinellae* started to attack *C. septempunctata algerica* within 24 h and after two days started to attack *H. variegata* when we put them together. The incubation period of *D. coccinellae* eggs and larval development was not quantified. After the larva emerged a cocoon was formed within 24 h. The adult emerged from after eight days for *C. septempunctata algerica* and after nine days for *H. variegata*. The developmental cycles of the parasitoid in the two hosts *C. septempunctata algerica* and *H. variegata* are comparable.

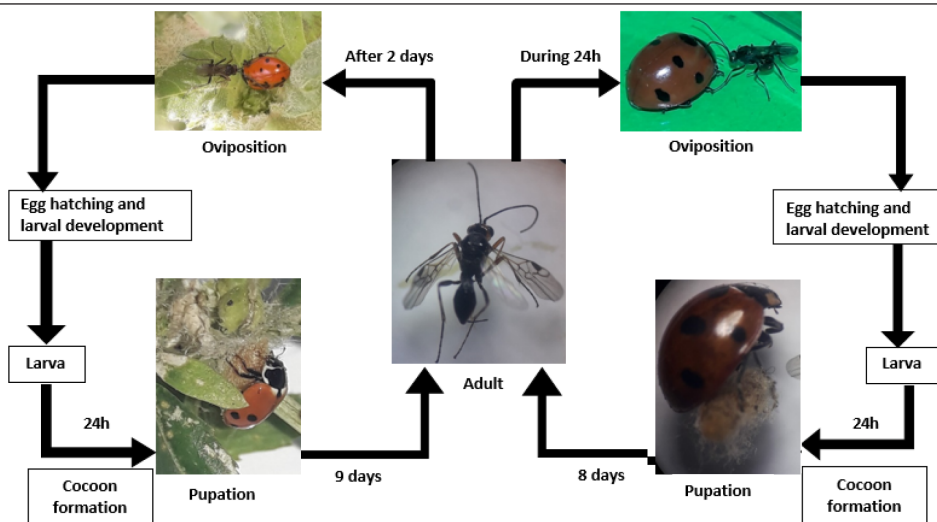


Fig. 3. Developmental cycle of *D. coccinellae* parasitizing *C. septempunctata algerica* and *H. variegata*.

Fig. 3. Ciclo de desarrollo de *D. coccinellae* en la parasitación de *C. septempunctata algerica* y *H. variegata*.

Discussion

During the survey, the ladybeetle most frequently found was *C. septempunctata algerica*. This study reports the parasitism of *Dinocompus coccinellae* on this species for the first time in Algeria. The parasitism rate was higher on *C. septempunctata algerica* (between 3.33 and 20.31%) than on *H. variegata* (between 0 to 6.7%). Obrycki (1989), Orr et al. (1992) and Triltsch (1996) also found a higher parasitism rate (12.5 to 47%) on *C. septempunctata*. The rates of parasitism species of ladybeetles vary in the literature. Berkvens et al. (2010) reported a rate of between 0 and 14.7% for *Harmonia axyridis*, and Rebolledo et al. (2009) and Tavooi Ajvad et al. (2012) both found rates of approximately 30% on *H. variegata*. Our results differ somewhat from those of the cited authors. We did not observe parasitism by *D. coccinellae* on *H. axyridis* collected in the fields near Boumerdes. It is of note *H. axyridis* is an introduced species in Algeria; it was first reported in Algiers by Lakhali et al. (2018). Majerus et al. (2000) and Davis et al. (2006) noted that females of *C. septempunctata* are more often parasitized than males. These authors suggested that due to their size, females would provide more trophic substance for the development of *D. coccinellae* larvae. The results of our study support this hypothesis.

In conclusion, our findings suggest that *C. septempunctata algerica* in Algeria is a sub-optimal host for *D. coccinellae* as for other ladybeetle species because the number of ladybugs that were parasitized was low compared to the number of ladybugs that were not parasitized. The parasitoid fauna of ladybeetle parasitoids in neighboring regions of Algeria is known to contain species that have not yet been studied for this country. The present work is a preliminary study that should be completed by surveys in other biotopes in order to understand the procession of natural enemies of *Coccinella septempunctata algerica* and other Coccinellidae species.

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