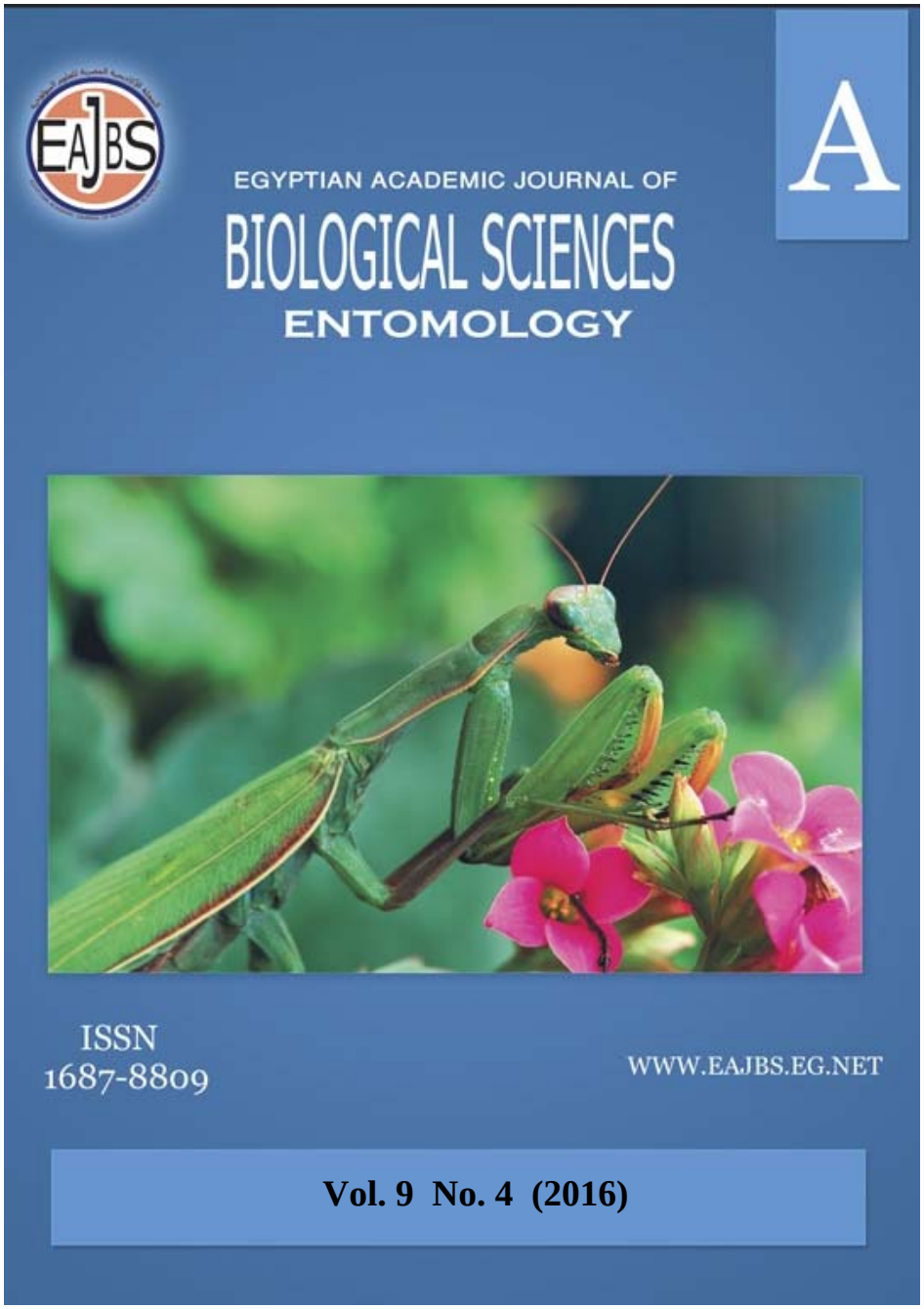

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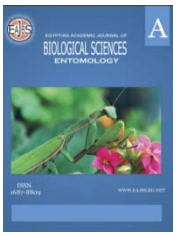

Predators, Parasitoids and Hyperparasitoids Associated With the Cotton Mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) Infesting Different Host Plants at Giza Region.

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ABSTRACT

Predators, parasitoids and hyperparasitoids associated with nymphal and adult stages of the cotton mealybug, *Phenacoccus solenopsis* infesting five ornamental host plants and six weeds were surveyed at Giza region, Egypt in 2015. Such study was not previously handled in Egypt. The survey revealed the presence of six predaceous species, two endoparasitoids and four hyperparasitoids. Most of the predators were recorded on the two host plants *Lantana camara* and *Hibiscus rosa-sinensis*. However, no predators were surveyed on the two infested host plants *Corchorus olitorius* and *Amaranthus ascendens*. Among the predators; the two species *Hyperaspis vinciguerrae* and *Scymus syriacus* were the most abundant. Two endoparasitoids; *Acerophagus gutierreziae* and *Chartocerus dactylopii* were served. The parasitoid, *A. gutierreziae* developed solitarily on the nymphs of its host and gregariously (2-5 individuals) on its adult stage; probably due to the host size while, *C. dactylopii* developed solitarily inside nymphs of its host.

INTRODUCTION

The newly world species of mealybug, *Phenacoccus solenopsis* Tinsley has emerged as a serious pest of cotton in Pakistan and India, and is now a serious threat to cotton in China. It has been reported from 173 species in 45 families, and from 26 countries in different ecological zones (Abbas *et. al*., 2010).

In Egypt, this pest was recorded for the first time infesting *Hibiscus* sp. in September, 2009 by Abd-Rabou *et al*., 2010 and in 2015, it was reported by Samah *et al*., on tomato as a new host plant. Since this year, this pest spreads rapidly on different host plants to the extent that Abd-Razzik *et al*., (2015) recorded it on 29 host plant species belonging to 16 plant families including field crops (3), vegetables (3), ornamentals (7), weeds (13) and fruits (3).

The natural enemies associated with this pest could play a good role in reducing its populations. A wide range of predators and parasitoids are previously reported in different parts of the world on this serious pest on many economic and important

plants, especially on cotton (Kedar *et al*., 2011; Arif, 2012; Neetan and Naveen, 2011; Aleixandre *et al*., 2013). As far as the present authors are aware, no information concerning the associated bio-agents of this pest were reviewed in Egypt. Therefore, this point of study represents the main goal of the present investigation.

MATERIALS AND METHODS

Collection: This study was carried out on five ornamental host plants and six species of weeds. Samples of branches, 10 cm long (seven replicates) infested with the mealybug, *P. solenopsis* were collected from each of the five ornamental host plants during summer (July & August) and from each of the six weeds during autumn (September, October & November) of 2015, and kept in carton boxes until emergence of associated bio-agents.

Identification: The host plants of weeds were identified by Prof. Dr. Ahmed Sadek Kholousy at Weed Research Laboratory, Agric. Res. Centre, Giza, Egypt, while ornamental host plants were identified by Prof. Dr. Mohamed Abd El-Khalek El-Kateeb at Ornamental Horticulture, Faculty of Agric., Cairo University.

The collected species of predators were identified by Prof. El-Akkad, M. K. at Insects Identification and Survey Section in Plant Protection Research Institute, Egypt. However, the cecidomyiide predator was sent to Dr. Keith Harris (the specialist of Fam. Cecidomyiidae) at Natural History Museum for identification and it was identified as *Dicrodiplosis manihoti* Harris (Diptera: Cecidomyiidae).

The collected species of parasitoids and hyperparasitoids were mounted on slides using Hoyer's medium, for identification that was done by the specialists of the Plant Protection Research Institute, Egypt. However, two parasitoids were sent to Natural History Museum for identification. The encyrtid parasitoid was identified by Dr. John Noyes as *Acerophagas gutierreziae* (Hymenoptera: Encyrtidae) and voucher material was deposited in the Natural History Museum and the signiphorid parasitoid was identified by Dr. Andrew Polaszek as *Chartocerus dactylopii* (Ashmead) (Hymenoptera: Signiphoridae). To all of them, the authors are greatly appreciated.

RESULTS AND DISCUSSION

Predators associated with *P. solenopsis* on different surveyed host plants:

Seven predaceous species were recorded associating with the pest, *P. solenopsis* on the different surveyed host plants. These species were *Hyperaspis vinciguerrae* Capra (Coccinellidae), *Scymnus syriacus* Mars (Coccinellidae), *Nephus* (Sidis) *hiekei* Fursch (Coccinellidae), *Dicrodiplosis manihoti* Harris (Cecidomiidae), *Chrysoperla carnea* (Stephens) (Chrysopidae), *Sympherobius amicus* Navas (Hemerobiidae) and *Orius albidipennis* (Reuter) (Anthocoridae) (Table 1). As shown in table 1, the host plant *Lantana camara* was the sole host plant that harboured all the seven surveyed predators, with varied degrees of existence. The Coccinellid, *S. syriacus* was represented by the highest number (3.7 individuals/ branch), followed by the cecidomyiid, *D. manihoti* (3.57 individuals/ branch) and the anthocorid, *O. albidipennis* (2.43 individuals/ branch). The remaining secured predators were represented by numbers ranged from 0.57 – 1.71 individuals / branch.

In this concern, many authors recorded that, the coccinellid predators play a good role in reducing the infestation of *P. solenopsis* (Kedar *et al*., 2011 and Vinay *et al*., 2016).

Table 1: Mean numbers of predators associated with *P. solenopsis* on the different eleven host plants during summer and autumn of 2015 at Giza region

Host plant category	Date of collection	Scientific name of host plant and its family	Mean ±SE	Predators						
				Scumnus syriacus	*Nephus hiekei*	*Hyperaspis vinciguerrae*	*Dicrodiplosis manihoti*	*Sympherobius amicus*	*Chrysoperla carnea*	*Orius albidipennis*
Ornamental plants	July	*Lantana camara* (Verbenaceae)	Mean	3.71	1.71	1.14	3.57	1.71	0.57	2.43
			SE	0.26	0.17	0.13	0.19	0.27	0.19	1.29
		Hibiscus rosa- sinensis (Malvaceae)	Mean	3.43	0.00	4.29	1.57	1.29	0.43	1.29
			SE	0.28	0.00	0.17	0.19	0.17	0.17	0.17
		Wedelia triobata (Asteraceae)	Mean	0.00	0.00	0.00	0.00	1.43	0.00	0.00
			SE	0.00	0.00	0.00	0.00	0.19	0.00	0.00
	Aug.	*Buddleia asiatica* (Buddleiaceae)	Mean	3.57	0.00	1.43	0.00	0.00	0.00	0.00
			SE	0.27	0.00	0.19	0.00	0.00	0.00	0.00
		Dalia X hybrida (Asteraceae)	Mean	0.00	0.00	6.00	3.29	0.00	0.00	0.00
			SE	0.00	0.00	0.20	0.17	0.00	0.00	0.00
Weeds	Sept.	*Tribulus longipetalus* (Zygophyliaceae)	Mean	0.00	0.00	0.71	0.57	0.00	0.00	0.00
			SE	0.00	0.00	0.17	0.19	0.00	0.00	0.00
		Corchorus olitorius (Malvaceae)	Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Amaranthus ascendens (Amaranaceae)	Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Oct.	*Xanthium pungens* (Asteraceae)	Mean	0.00	0.00	2.29	0.00	0.00	0.00	0.00
			SE	0.00	0.00	0.17	0.00	0.00	0.00	0.00
		Withania somnifera (Solanaceae)	Mean	0.00	0.00	0.00	1.43	0.00	0.00	0.00
			SE	0.00	0.00	0.00	0.19	0.00	0.00	0.00
	Nov.	*Solanum nigrum* (Solanaceae)	Mean	0.00	0.00	1.29	0.00	0.00	0.00	0.00
			SE	0.00	0.00	0.17	0.00	0.00	0.00	0.00

The host plant, *Hibiscus rosa-sinensis* ranked the second category in harbouring the predaceous species, all the predators were represented except the coccinellid, *N. hiekei.* Associating with this host plant, the predator *H. vinciguerrae* was represented by the highest count (4.29 individuals / branch), followed by the coccinellid, *S. syriacus* (3.43 individuals / branch). On the contrary, the two weed host plants *Corchorus olitorius* and *Amaranthus ascendens* did not harbour any of the seven surveyed predators. The remaining host plants harbouring from one to two predaceous species (Table 1).

Regarding the existence of the secured predators on the eleven surveyed host plants, it appeared that the coccinellid predator, *H. vinciguerrae* occupied the first category. It existed on seven host plants out of the eleven ones, followed by the cecidomyiid species, *D. manihoti* that was found on five host plants. However, the least existence was represented for the predator, *N. hiekei* that was collected from the host plant, *L. camara* only with a count of 1.71 individuals / branch. On the other hand, either of the predators, *S. syriacus*, *S. amicus* or *C. carnea* was collected from three host plants, while the anthocorid, *O. albidipennis* was found on two host plants only.

The maximum number of predators collected (6.0 individuals / branch) was reported for the predator *H. vinciguerrae* on the host plant *Dalia × hyhrida*, while the least number (0.43 individuals / branch) was recorded for the chrysopid, *C. carnea* on the host plant *H. rosa-sinensis* (Table 1).

Primary parasitoids associated with *P. solenopsis* on the different surveyed host plants

Two primary parasitoids; *Acerophagus gutierreziae* (Encyrtidae) and *Chartocerus dactylopii* (Signiphoridae) were secured from the mealy bug individuals, *P. solenopsis* during the course of this investigation.

It was noted that, the common parasitoid, *A. gutierreziae* developed solitarily (Fig. 1, A) in the nymphs of the host and gregariously (Fig.1, B) (from 2-5 individuals) inside its adult stage. The gregarious parasitoid did not emerge from one exit-hole. It emerged through a number of exit-holes equal to that of the emerged parasitoids.

Fig. 1: Emergence holes of the parasitoid, *Acerophagus gutierreziae;* developed solitarily (A) and gregariously (B).

Most of the parasitoid progeny developed solitarily (89.33 – 100%) and the few developed gregariously (3.96 – 10.67%) on the three host plants; *Xanthium pungens*, *Hibiscus rosa -sinensis* and *Lantana camara* (Fig. 2) where the populations of the parasitoid were height on them (Table, 2). The primary encyrtid parasitoid, *A. gutierreziae*. was represented by varied numbers on their hosts located on nine host plants only, where no parasitoids were secured from hosts located on the two host plants; *Dalia* × *hyprida* and *Tribulus longipetalus* (Table 2).

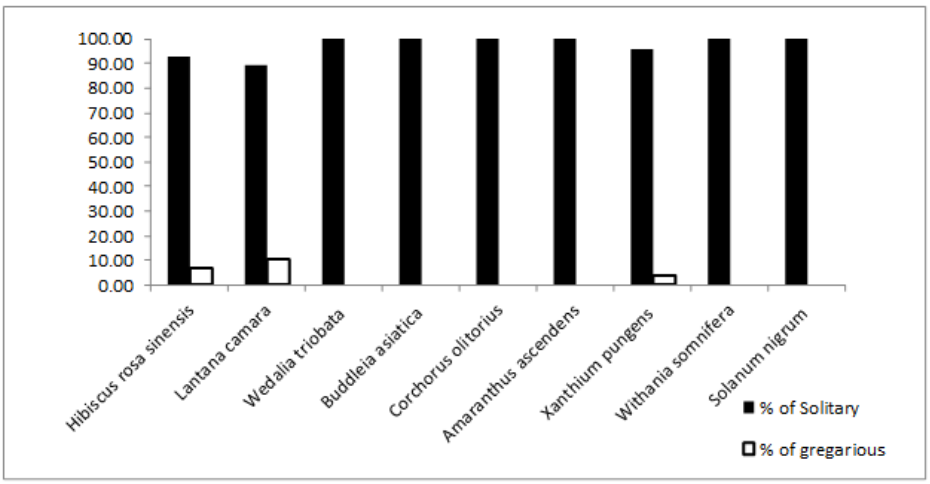

Fig.2: Percent of the solitary and gregarious individuals of the parasitoid, *A. gutierreziae* on different host plants at Giza region during summer and Autumn 2015.

Number of emerged parasitoids of *A. gutierreziae* ranged from 1.57 individuals / branch to 19.86 individuals / branch. The highest count was reported for the insect hosts located on the host plant, *Xanthium pungens* while the lowest one was for *Solanum nigrum*. Relatively high numbers (12.43 – 14.00 individuals / branch) were also reported for insect hosts existed on the host plants; *Weddelia triobata, L. camara* and *H. rosa-sinensis* (Table 2). As shown in Figure (3), Percent of *A. gutierreziae* females ranged from 50 - 53% on different host plants.

Table 2: Mean numbers of the parasitoid and hyperparasitoids associated with *P. solenopsis* on different eleven host plants during summer and autumn of 2015 at Giza region

Host plant category	Date of collection	Scientific name of host plant and its family	Mean ±SE	Parasitoids and hyperparasitoids					
				Primary parasitoids		Hyperparasitoids			
				Acerophagus gutierreziae	*Chartocerus dactylopii*	*Chartocerus subaeneus*	*Marietta* sp.	*Prochiloneurus aegyptiacus*	*Pachyneuron* sp.
Ornamental plants	July	*Lantana camara* (Verbenaceae)	Mean	13.86	1.29	1.71	0.00	0.43	0.00
			SE	0.51	0.17	0.27	0.00	0.19	0.00
		Hibiscus rosa- sinensis (Malvaceae)	Mean	14.00	1.86	0.00	0.00	0.00	0.00
			SE	0.61	0.70	0.00	0.00	0.00	0.00
		Wedelia triobata (Asteraceae)	Mean	12.43	2.00	0.00	0.43	1.71	1.71
			SE	0.70	0.29	0.00	0.19	0.27	0.17
	Aug.	*Buddleia asiatica* (Buddleiaceae)	Mean	3.86	1.29	0.00	0.00	0.00	0.00
			SE	0.24	0.17	0.00	0.00	0.00	0.00
		Dalia X hybrida (Asteraceae)	Mean	0.00	0.00	0.00	0.00	0.00	0.00
			SE	0.00	0.00	0.00	0.00	0.00	0.00
Weeds	Sept.	*Tribulus longipetalus* (Zygophyliaceae)	Mean	0.00	0.00	0.00	0.00	0.00	0.00
			SE	0.00	0.00	0.00	0.00	0.00	0.00
		Corchorus olitorius (Malvaceae)	Mean	3.71	0.00	0.00	0.00	0.00	0.00
			SE	0.27	0.00	0.00	0.00	0.00	0.00
		Amaranthus ascendens (Amaranaceae)	Mean	2.57	0.00	0.00	0.00	0.00	0.00
			SE	0.19	0.00	0.00	0.00	0.00	0.00
	Oct.	*Xanthium pungens* (Asteraceae)	Mean	19.86	3.29	0.00	0.57	0.00	0.00
			SE	0.65	0.17	0.00	0.19	0.00	0.00
		Withania somnifera (Solanaceae)	Mean	2.71	0.00	0.00	0.00	0.00	0.00
			SE	0.17	0.00	0.00	0.00	0.00	0.00
	Nov.	*Solanum nigrum* (Solanaceae)	Mean	1.57	0.00	0.00	0.00	0.00	0.00
			SE	0.19	0.00	0.00	0.00	0.00	0.00

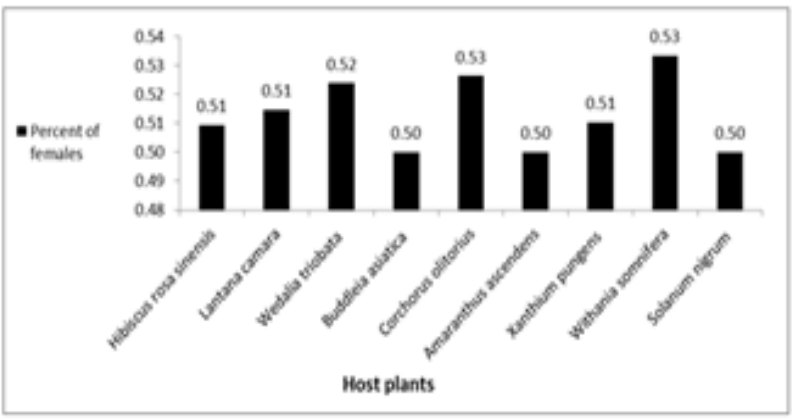

Fig. 3: Percent of *Acerophagus gutierreziae* females emerged from insect hosts located on the different host plants at Giza region during summer and autumn 2015.

The endoparasitoid signiphorid, *Chartocerus dactylopii*, was also recorded during the present investigation, it parasitizes nymphs of the insect host, *P. solenopsis* and developed solitarily inside it and all the emerged offspring were females. It was recorded by numbers ranged from 1.29-3.29 individuals / branch on the five host plants; *Hibiscus rosa-sinensis*, *Lantana camara*, *Wedalia tribata*, *Buddleia asiatica* and *Xanthium pungens* .

Hyperparasitoids associated with the primary parasitoids:

Four hyperparasitoids were secured associating with the two primary parasitoids; *A. gutierreziae* and *C. dactylopii.* These hyperparasitoids; were *Chartocerus subaeneus* (Signiphoridae), *Marietta* sp. (Aphelinidae), *Prochiloneurus aegyptiacus* (Encyrtidae) and *Pachyneuron* sp. (Pteromalidae) (Table2). The two hyperparasitoids *Marietta* sp. and *P. aegyptiacus* were represented by two records for each, 0.43&0.57 and 0.43&1.71 individuals / branch, respectively. The other remaining two hyperparasitoids; *C. subaeneus* and *Pachyneuron* sp. were represented by 1.71 individuals / branch for each (Table 2).

In conclusion, the cotton mealybug, *P. solenopsis* is one of the destructive pests that attacks cotton, vegetables, ornamental plants and weeds in different parts of the world (Abbas *et al*., 2010, Arif *et al*., 2012 and Abd-Razzik *et al*., 2015). Associating with this pest, different species of predators and parasitoids were previously reported by several authors (Kedar *et al*. 2011; Neetan and Naveen, 2011; Arif, 2012; Aleixandre *et al*. 2013).

In Egypt, the survey of these bio-agents was not previously handled. In the present investigation, seven predaceous species, two parasitoids and four Hyperparasitoids were surveyed associating with this pest on eleven different ornamental and weed host plants. Despite the oneness of the insect pest on the different surveyed host plants, the numbers and existence of such bio – agents varied widely from one host plants to another, to the extent that they disappeared completely on certain host plants during the whole period of study.

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