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ECOLOGICAL STUDIES ON INSECT PARASITOIDS ATTACKING PINK HIBISCUS MEALYBUG *Maconellicoccus hirsutus* (GREEN) (HEMIPTERA: PSEUDOCOCCIDAE) AT KAFR EL- SHEIKH GOVERNORATE

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ABSTRACT

A search for the Parasitoids of the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) was conducted at Kafr El- Sheikh Governorate. Two parasitoids were recorded; the first one was *Allotropa mercida* (Walker) (Hymenoptera: Platygastridae) which was the most abundant with 13.37 and 16.84 % parasitism during 2005/06 - 2006/ 07, while the second one was *Anagyrus kamali* (Moursi) (Hymenoptera: Encyrtidae) with 6.68 and 5.75 % parasitism. The parasitoids were found during a period extending from mid March till early December, and the highest populations of the both parasitoids occurred in September. Both parasitoids, *A. kamali* and *A. mercida* population exhibited positive response to the increase of its host population. The effect of temperature and relative humidity on parasitoids was assessed during various seasons.

Keywords: *Maconellicoccus hirsutus*; *Anagyrus kamali*; *Allotropa mecrida*; Encyrtidae; Platygastridae; Parasitism.

INTRODUCTION

The pink hibiscus mealybug *Maconellicoccus hirsutus* (Green) (PHM) (Hemiptera: Pseudococcidae) is the most injurious mealy bug species occurring in Egypt following its introduction in about 1908, presumably from India, and by 1926 it was generally distributed all over the country (Mousa *et al* 2001) a dangerous pests attacking grapes in Upper Egypt (Abd- Rabou, 2000) It attacks a wide variety of host plants and feeds on the developing sprouts after pruning and stunts their growth. The growing shoots and the leaves are swollen and malformed due to sticky honeydew produced by the pest, predisposing them to moldy growth and bunching. Heavily infested bunches shrivel and drop. Damage can be occasionally as much as 90% (Meyerdirk *et al.*, 1981). In order to counteract the rapid and destructive spread of this pest, biological control appeared to be a promising tactic. Two species of parasitoids associated with *M. hirsutus*, *Anagyrus dactylopii* and *Allotropa* sp. near japonica Ashm was recorded Mani *et al.* (1987). The solitary endoparasitioid *Anagyrus kamali* (Moursi) was identified in 1934, and adapted to attack *M. hirstutus*, and became established (Mousa *et al* 2001).It was imported from China into the Caribbean for that purpose (Pollard 1995). It proved to be an efficient biological control agent against mealybugs in Egypt and India (Williams 1996). Also, this parasitoid had a good role in

suppressinng the PHM populations and contributed a high rate of its mortality (Abdel- Mageed 2005). *A. kamali* was highly effective in bringing hibiscus mealybug populations under control especially in newly infested countries. Introduction of biological control agents resulted in effective management of the pest (Sagarra and Peterkin 1999). The parasitoid was released in grape orchards infested with *M. hirsutus* at two locations in Egypt and it was an effective parasitoid in controlling the pest (Abd- Rabou 2008)

Allotropa japonica parasitized *M. hirstutus* (Mani and Krishnamoorthy 1989).Also *Anagyrus dactylopii* Howard and *Allotropa* sp. near *japonica* Ashm. (Platygasteridae) and *A. dactylopii* was the dominant parasitoid, (Mani and Thontadarys 1987, Mani 1988). *A. mercida* (Walker) was by far the most abundant parasitoid attacking PHM in Egypt, and the highest rate of parasitism was at Delta region. *A. mecrida* had a significant potential for reducing PHM in California for several seasons. First, this is gregarious parasitoid; thus many parasitoids produced from each host whereas solitary parasitoids only produce one parasitoid from each host. A second important characteristic is that *A. mecrida* survive under wide range of temperature and relative humidity conditions. *Allotropa* sp. near *mecrida* was collected from southern Egypt in 2000 and exported into the desert climate of the Imperial Valley, California for biological control of the PHM (Gonzalez *et al.* 2003). *Allotropa* sp*., Anagyrus kamali* were recorded associated with it in Egypt (Abd-Rabou and Hendawy 2005) and parasitism was the highest in the Delta (80%) and the lowest in Upper Egypt (Mousa *et al* 2001). *A. kamali* and *A. Mecrida* were reared and released for permanent establishment for biological control against *M. hirsutus* in southern California (Roltsch *et al.* 2006). the present work aims to investigate the following points:

1- Survey and Seasonal abundance of the parasitoids attacking *M. hirsutus* on The Chinese hibiscus, (Hibiscus rosa-sinensis Linnaeus).
2- Relationships between the host, *M. hirsutus* and its parasitoids
3- Effect of temperature and relative humidity on the seasonal abundance of *M. hirstus* parasitoids.

MATERIALS AND METHODS

Population fluctuations of parasitoids of pink hibiscus mealybug *Maconellicoccus hirsutus* (Green) at Kafr El- Sheikh:

Survey was conducted for two successive years, 2005-2006 and 2006-2007, ten heavily infested terminal shoots (~ 30 in long) were selected for studying the major parasitoids associated with pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) and its seasonal abundance. Plants were sampled and taken biweekly. The collected samples were transferred to the laboratory in polyethylene bags and kept in emergence wood boxes (50 x20 x 20 cm.) for collecting the emerged parasitoids. A glass tube was inserted into a round hole of the box. An electric lamp (60 w.) was placed next to the tube to attract emerging parasitoids. Emerging parasitoids were monitored and collected daily and new tubes were provided. Parasitoids were identified by specialists of the Biological Control Research Department, Plant Protection

Research Institute, Giza, Egypt. The correlation coefficient (r) values were calculated to determine the relationship between the total number of the hibiscus mealybug and their parasitoids, Data were analyzed statistically using SPSS software program according to Duncan, (1955).

RESULTS AND DISCUSSION

Population fluctuations of the pink hibiscus mealybug *Maconellicoccus hirsutus* parasitoids (Green) at Kafr El- Sheikh:

In the present work, two primary hymenopterous parasitoids; *Allotropa mercida* and *Anagyrus kamali* were found; the firs one was more dominant than the second. Also, Mousa *et al.*(2001) recorded *Allotropa mercida* (Walker), *Anagyrus kamali* Moursi and *Marietta sp.* on *Maconellicoccus hirsutus*.

Allotropa mercida was the dominant species as represented by total number of 440 and 556 during 2005/06 and 2006/07, compared to *Anagyrus kamali, which* was represented by 220 and 190 individuals in the two years, respectively. Tables (1 and 2) and Fig. (1 and 2).

Data represented in Table (1) and illustrated in Figure (1) showed that the parasitoid *A. mercida* had two peaks of abundance during the first and second years of study (2005/06-2006/07). The first one was recorded on the 1st of June in the first (26 individuals/ sample) and second seasons (29 individulals/ sample). The second one recorded on the mid of August and at the beginning of September during the first (represented by 51 individuals/ sample) and the second season (represented by 75 individuals/ sample) respectively.

According to the abundance of *A. kamali* individuals on *M. hirsutus*, three peaks were recorded in the first year of study (2005/06). These peaks were recorded on the 15th of April, 15th of June, and on mid-September with total number of 14, 12 and 36 individuals/ sample respectively. In the second year (2006/07) the parasitoids exhibited two peaks, on mid April and 1st of October, represented by 19 and 30 individuals respectively.

The total number of parasitoids exhibited one peak in the first year on mid September, by 76 individuals. In the second year, there were two peaks on early September and on mid-November by 95 and 39 individuals, respectively. The parasitoid disappeared from mid November till early February in the first year, while in the second year it disappeared from December till late Feb.. Comparison among total parasitoid means in two seasons was not significant (P = 0.602).

It was observed that hibiscus shrubs harbored different ant species (Hymenoptera: Formicidae) were free from parasitoids, ants were clearly associated with increased mealybug densities. Many of hibiscus shrubs characterized with ants association were inspected and no parasitoids were found. This is because ants are normally attracted to the honeydew excreted by mealybug.

Table (1): Parasitism percentages of hymenopterous parasitoids attacking the pink hibiscus mealybug *Maconellicoccus hirsutus* (Green) at Kafr El-Sheikh governorate during 2005/06 season.

Sampling date		*M. hirsutus* /50 leaves	*Allotropa mecrida*		*Anagyrus kamali*		Total parasitism	
			No.	%	No.	%	No.	%
Apr.	1/2005	143	12	8.38	10	6.98	22	15.36
	15	260	18	6.92	14	5.39	32	12.31
May	1	249	15	6.02	13	5.22	28	11.24
	15	160	19	11.88	6	3.75	25	15.63
June	1	172	26	15.12	6	3.49	32	18.61
	15	190	17	8.95	12	6.32	29	15.27
July	1	170	23	13.53	7	4.12	30	17.65
	15	178	36	20.22	10	5.62	46	25.84
Aug.	1	198	32	16.16	12	6.06	44	22.22
	15	190	51	26.84	19	10.00	70	36.84
Sept.	1	200	40	20.00	30	15.00	70	35.00
	15	181	40	22.09	36	19.90	76	41.98
Oct.	1	105	23	21.90	13	12.38	36	34.28
	15	168	21	12.50	7	4.17	28	16.67
Nov.	1	99	25	25.25	2	2.02	27	27.27
	15	103	19	18.45	0	0	19	18.45
Dec.	1	93	13	13.98	0	0	13	13.98
	15	69	5	7.25	0	0	5	7.25
Jan.	1/2006	20	0	0	0	0	0	0
	15	8	0	0	0	0	0	0
Feb.	1	14	0	0	0	0	0	0
	15	58	0	0	2	3.44	2	3.44
Mar.	1	120	0	0	6	3.45	6	5.00
	15	142	5	3.52	15	5.00	20	14.08
Total		**3290**	**440**	**13.37**	**220**	**6.68**	**660**	**20.06**
Mean± SD		**137.1+ 69**	**18.33+ 14.41**	**11.62+ 8.59**	**9.17+ 9.33**	**5.10+ 5.01**	**27.50+ 21.83**	**17.02+ 11.84**

P = 0.012 Comparison between two parasitoid means was significant at (0.05)

These observations agree with Daane *et al.* (2007), who reported that Argentine ant, *Linepithema humile*, tends honeydew-excreting homopterous and can disrupt the activity of their natural enemies and ant tending increased densities of the obscure mealybug, *Pseudococcus viburni* , and lowered densities of its encyrtid parasitoids. Similary for the parasitoid of *Ceroplastes rubens*, *Anicetus beneficus* Ishii., encyrtidae and attendant ant (*Lasius niger*), Itioka and Inoue (1996).

Variations of The total number of parasitoids during the two-year study may be attributed to the refuge of *M. hirsutus* under bark and on roots, where it is protected from extreme temperatures and natural enemies (Daane *et al.* 2003) and insecticide applications (Walton 2003). It also has a temporal refuge, created when tending ants reduce the efficacy of natural enemies (Daane *et al.* 2006)

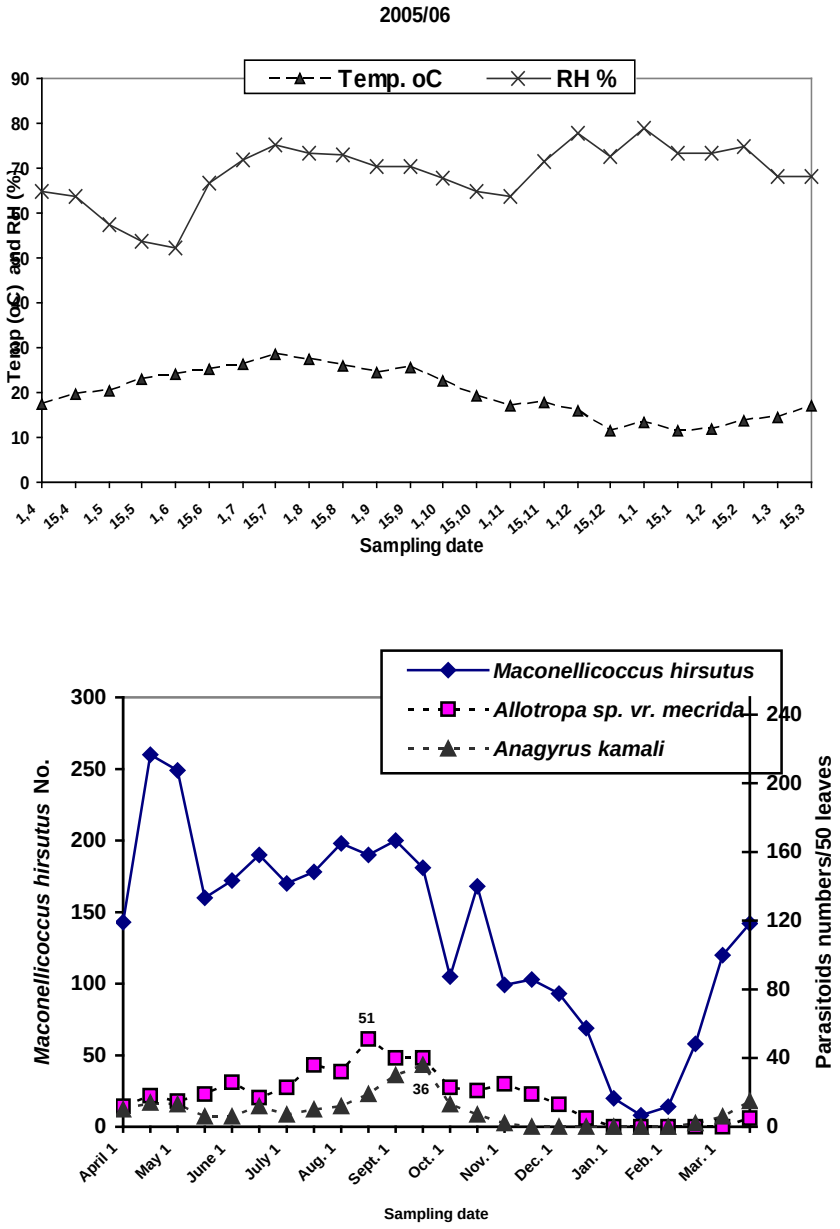

Fig. (1): Seasonal abundance of the endoparasitoids (*A. mercida* and *A. kamali*) and its host *Maconellicoccus hirsutus* on The Chinese hibiscus, *Hibiscus rosa-sinensis* Linnaeus during season 2005/06 season at Kafr El-Sheikh governorate.

Table (2): Parasitism percentages of hymenopterous parasitoids attacking pink hibiscus mealybug *Maconellicoccus hirsutus* (Green) at Kafr El-Sheikh governorate during 2006/07 season.

Sampling date		*M. hirsutus* /50 leaves	*Allotropa mecrida*		*Anagyrus kamali*		Total parasitism	
			No.	%	No.	%	No.	%
Apr.	1/2006	142	14	9.86	17	11.97	31	21.83
	15	200	17	8.50	19	9.50	36	18.00
May	1	231	19	8.23	17	7.36	36	15.59
	15	193	22	11.40	10	5.18	32	16.58
June	1	210	29	13.81	7	3.18	36	16.99
	15	204	22	10.78	8	3.92	30	14.70
July	1	179	28	15.64	2	1.12	30	16.76
	15	192	33	17.19	4	2.07	37	19.26
Aug.	1	179	49	21.79	6	3.91	55	25.70
	15	199	49	24.62	8	4.02	57	28.67
Sept.	1	223	75	33.60	20	8.97	95	42.57
	15	193	50	25.91	15	7.76	65	33.67
Oct.	1	213	37	16.02	30	12.99	67	29.01
	15	182	28	15.38	18	9.89	46	25.27
Nov.	1	110	23	20.91	6	5.45	29	26.36
	15	121	38	31.40	1	0.83	39	32.23
Dec.	1	103	19	18.45	0	0	19	18.45
	15	42	0	0	0	0	0	0
Jan.	1/2007	17	0	0	0	0	0	0
	15	0	0	0	0	0	0	0
Feb.	1	10	0	0	0	0	0	0
	15	16	0	0	0	0	0	0
Mar.	1	60	1	1.67	0	0	1	1.67
	15	82	3	3.66	2	2.49	5	6.15
Total		**3301**	**556**	**16.84**	**190**	**5.75**	**746**	**22.60**
Mean± SD		**137.5+ 77.6**	**23.17+ 19.86**	**12.87+ 10.20**	**7.92+ 8.49**	**4.19+ 4.17**	**31.08+ 25.31**	**17.06+ 12.36**

P = 0.001 Comparison between two parasitoid means was highly significant at (0.05)

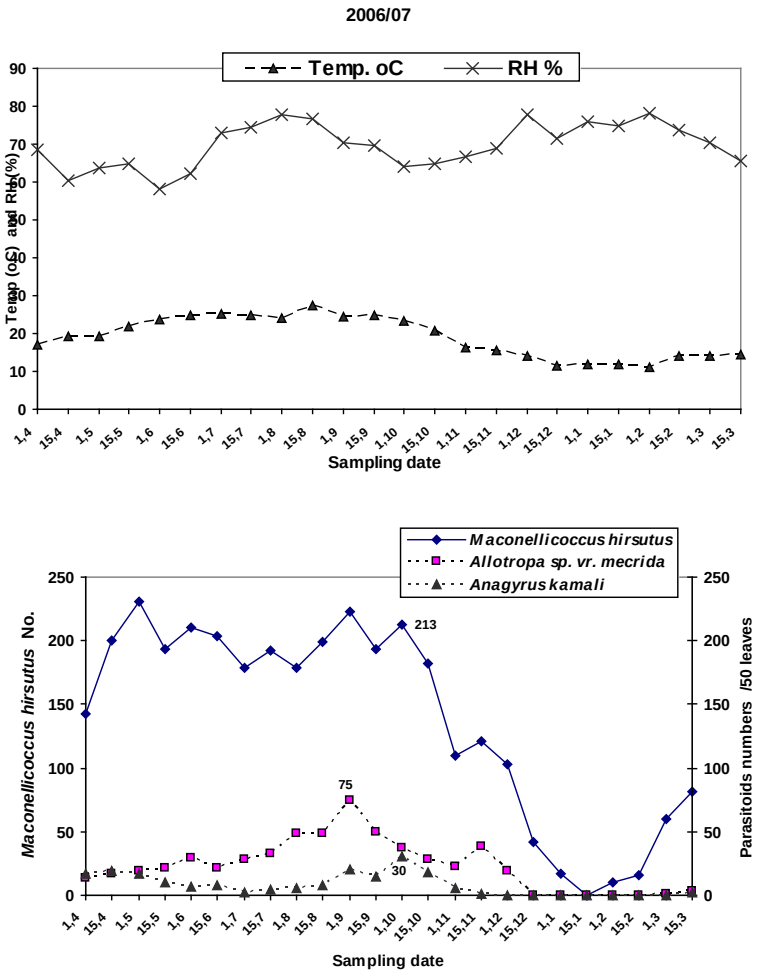

Fig. (2): Seasonal abundance of the endoparasitoids (*A. mercida* and *A. kamali*) and its host *Maconellicoccus hirsutus* on The Chinese hibiscus, *Hibiscus rosa-sinensis* Linnaeus during season 2006/07 season at Kafr El-Sheikh governorate.

Relationship between the host, *Maconellicoccus hirsutus* (Green) and its parasitoid populations:

As shown in Table (3), Fig. (3), the correlation coefficient value (r) between the host and parasitoid populations was relatively high in both years of the study. There were highly significant correlations between the host and *Allotropa mercida* in both years (0.643 and 0.754), Also, the second parasitoid, *Anagyrus kamali* had a highly positive correlation with the host (r= 0.645 and 0.712) in both years, respectively. In respect to the correlation between the host and its parasitoid populations during the various seasons

was summarized in Table (4); in the first year there were significantly positive correlation during spring and winter (0.812 and 0.838), and non-significant correlations during summer and autumn (0.432 and 0.792). In the second year, there were highly significant positively correlations during spring (0.946) and winter (0.930), while it was significantly positive and insignificantly negative correlation during autumn (0.896) and summer (-0.188) seasons.

Similar results were obtained by Mani *et al.* (1987) and Abdel- Mageed (2005) they mentioned that there were positive and significant relationships between the parasitoid *Anagyrus dactylopii* and *M. hirsutus***.** Mousa *et al*. (2001) recorded the highest population of *M. hirsutus* and its parasitoids in September.

Table (3): Correlation coefficient values (r) between numbers of the pink hibiscus mealybug *Maconellicoccus hirsutus* (Green) and both parasitoid (*A. mercida* and *A. kamali*) numbers and parasitism percentages at Kafr El-Sheikh governorate.

Mealybug (Host)	Parasitoid		2005/06	2006/07
M. hirsutus	***Allotropa mecrida***	No.	0.643**	0.754**
		%	0.394	0.649**
	Anagyrus kamali	No.	0.645**	0.712**
		%	0.556**	0.672**
	Total	No.	0.700**	0.831**
		%	0.539**	0.763**

Effect of mean temperature and relative humidity on the seasonal abundance of *Maconellicoccus hirstus* parasitoids:

The correlation coefficient values between the parasitoid populations and both mean temperature and relative humidity during various seasons was calculated Table (4). From statistical analysis, there were positive and significant correlations between the total number of the parasitoids and mean temperature during autumn in the first year (0.916), while there were positive and no significant correlations in the other seasons, spring, summer and winter. In the second year, there were positive and significant correlations during spring and autumn (0.868 and 0.864 respectively), but no significant correlation during summer and winter.

Concerning the relationship between the total number of the parasitoids and relative humidity, there were positive and no significant correlations during summer, autumn and winter in the two years, and there was negative and no significant correlation during spring in the two years (-0.546 and -0.618 respectively).

Mani *et al.* (1987) refered to the activity of *Anagyrus dactylopii* while was positively correlated with maximum temperature and negatively with relative humidity. Gonzalez *et al.* (2003) reported that *Allotropa mercida* is closely associated with PHM under a wide range of environmental conditions. Abdel- Mageed (2005) reported that *Anagyrus kamali* (Moursi) exhibited a highly positive response to the increase in temperature but no response with relative humidity.

Table (4): Seasonal correlation between total number of parasitoids and both of mean temperature and relative humidity during 2005/06 and 2006/07 at Kafr El-Sheikh.

Year	Temp.& P.	RH.& P.	Temp.& P.	RH.& P.
Spring	0.767	- 0.546	0.868*	- 0.618
Summer	0.331	0.456	0.351	0.622
Autumn	0.916*	0.468	0.864*	0.416
Winter	0.689	0.310	0.559	0.469

H. : Total number of host **P. : Total number of parasitoids**
RH.: Relative humidity **Temp.: Temperature**

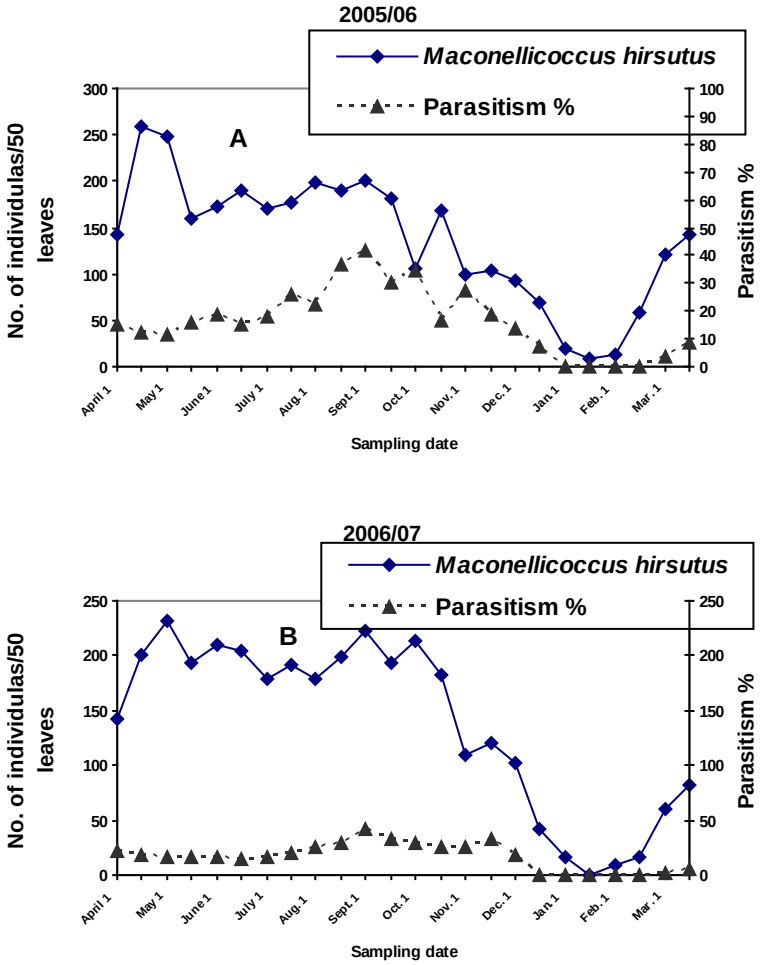

Fig. (3 A, B): Relationship between the host *Maconellicoccus hirsutus* and parasitoid activity (parasitism percentages), (*A. mercida* and *A. kamali*) at Kafr El-Sheikh governorate during 2005/05 and 2006/07 seasons.

Parasitoids activity:

Table (1) showed that the seasonal activity (parasitism %) of the parasitoid *Allotropa mercida* was represented by four peaks of parasitism, at the first year, in the beginning of June, mid-July, mid-August and early November as 15.12, 20.22, 26.84 and 25.25%, were computed respectively. In the second year it exhibited three peaks (Table 2), during the beginning of June (13.81%), the beginning of September (33.60%) and on mid-November (31.40%).

Regarding to *Anagyrus kamali,* it had two peaks in both years; on mid- June (6.32%) and on mid- September (19.90%) during2005/06 and early April (11.97%) and October (12.99%) during 2006/07.

In the first year, high total parasitism percentages were computed three times, on mid-July (25.84%), 15th September (41.98%) and on the 1st of November (27.27%). Also in the second year there were three peaks, on the 1st of April (21.83 %), 1st September (42.57 %) and on mid-November (32.23 %). The relationship between the host and parasitism percentage (Table 3) was highly significant during the first and second years, (0.53 and 0.763 respectively), But for *Allotropa mercida* it was non-significant during the first year, and highly significant during the second year (0.394 and 0.649 respectively). The correlation coefficient between the host and the parasitism % of *Anagyrus kamali* was highly significant during the two years (0.556 and 0.672 respectively).

Mani *et al.* (1987) recorded 62.5 % parasitism for *Anagyrus kamali***.** According to Mani and Thontadarys (1987) the highest activity of *Anagyrus dactylopii* was during the first week of March. while Mousa et al (2001) recorded the active period for both mealybug and its parasitoids exciteded from April to November on Hibiscus plant and *A. mercida* caused 69.5% parasitism. They added that *A. kamali* and *A. mercida* recorded the highest seasonal activity (parasitism) in the Delta (80%) and the lowest in Upper Egypt. Abdel- Mageed (2005) recorded A. kamali with 8.2- 10.9% of parasitism, the parasitoid activity exhibited three peaks of activity, yearly. These peaks were recorded in March, July (highest activity) and October – November and the parasitoid had a good synchronization with the change of host density.

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دراسات ايكولوجية على الطفيليات الحشرية التي تهاجم بق الهيبسكس الدقيق *Maconellicoccus hirsutus* (GREEN) في محافظة كفر الشيخ

عبد الحكيم الدمرداش الشربيني[1]، إبراهيم سعيد الهواري [1]، زكريا شنيشن فراج [1]، أحمد سمير هنداوي[2] و رانيا السيد مشعل[1]

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أجريت هذه الدراسة على شجيرات الهيبسكس فى محافظه كفر الشيخ خلال 2005 /2006، 2006/2007لحصر الطفيليات التى تهاجم بق الهيبسكس الدقيقي *Maconellicoccus hirsutus* (Green) ،أمكن تعريف نوعين من الطفيليات هما *Allotropa mercida* (Walker) ، *Anagyrus kamali* (Moursi) . كان الطفيل الأول أكثر نشاطا علي بق الهيبسكس الدقيق حيث بلغت نسبة التطفل 13.37 ،16.84 % خلال موسمي الدراسة علي التوالي، بينما كانت نسبة التطفل بالنوع الثاني هي6.68، 5.75 % .

تواجد كلا النوعين خلال فترة امتدت من منتصف مارس و حتى أوائل ديسمبر من كل موسم، وبلغت الكثافة العددية ذروتها خلال شهر سبتمبر. أيضا تم توضيح العلاقة بين الطفيليين و النشاط النسبى لهما و العائل، كذلك تأثير كلا من درجة الحرارة و الرطوبة على الطفيليات خلال الأربعة مواسم المختلفة.

قام بتحكيم البحث

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