Bull. Fac. Agric., Cairo Univ.,55 (2004): 145-164 .

THE BIOLOGICAL ACTIVITIES OF THE EGYPTIAN GEOGRAPHIC POPULATION OF THE PREDATORY APHID MIDGE, *Aphidoletes aphidimyza* (RONDANI) (DIPTERA: CECIDOMYIIDAE)

(Received:18.6.2003)

By

S.M.H. Sayed and S.A. Elarnaouty

Economic Entomology and Pesticides Department, Faculty of Agriculture, Cairo University, Giza

ABSTRACT

Biological studies of the predatory midge, *Aphidoletes aphidimyza* were carried out combining two variables: *i.e.*, temperature and prey species. All assays were run at 16 L: 8 D photoperiod and 60% R.H. Feeding on the cereal aphid, *Rhopalosiphum padi* was combined with three different temperatures ,20° C, 25° C and 30° C, whereas assays using *A. gossypii* and *A. craccivora* were done at 25° C. Results showed that the cereal aphid, *R. padi* induced low larval mortality and high female fecundity. The temperature of 25° C was selected for rearing this predator because it was associated with high hatchability, low larval mortality, high adult emergence rate and high female oviposition. The females of *A. aphidimyza* prefer to lay most of their eggs on the lower surface of the leaves. Moreover, the mean percentage of deposited eggs decreased gradually with decreasing aphid density on the plant.

Key words: *aphid , Aphidoletes aphidimyza , Aphis craccivora, Aphis gossypii,predator, rearing ,Rhopalosiphum padi, temperature.*

1. INTRODUCTION

The midge, *A. aphidimyza* (Rondani) (Diptera: Cecidomyiidae) is a general aphid predator, attacking many aphid species on different host plants (Wood-Baker, 1965 and Nijveldt, 1988). Morphological and biological studies of larvae, pupae and adults of *A. aphidimyza* were carried out by Roberti (1946). In Egypt, the morphology of all stages of *Phenobremia aphidivora* (=*A.aphidimyza*) with some aspects of its biology was studied by Ismail (1963). However, *A. aphidimyza* is considered a complex of various geographic populations, which differ in most biological parameters (Havelka and Zemek, 1999). This predator was investigated with respect to its suitability for the control of aphids in greenhouses (Markkula and Tiittanen, 1985). At the beginning of the 1970's, *A. aphidimyza* was used for the biological control of aphids in greenhouses (Krivan and Havelka, 2000). Before applying this predator for the biological control of aphids in Egypt, it was essential to study its biological activities under different temperatures with larval feeding on different aphid species in order to choose the best rearing temperature and the proper prey species for the mass production of *A. aphidimyza*.

2. MATERIAL AND METHODS

Individuals of the gall midge larvae, *A. aphidimyza* were collected from okra, *Abelmoschus esculentus* plants infested with the cotton aphid, *Aphis gossypii* in the Experimental Farm of the Faculty of Agriculture, Cairo Univ. Giza, Egypt. These larvae were transferred to the laboratory and provided with sufficient individuals of *A. gossypii* as food material in plastic boxes (15 X 20 X 10 cm). The boxes were bottomed with 2 cm high-moistened peat as a pupation substrate. A rectangular area of 12X17 cm was removed from the cover of the box and replaced by muslin cloth glued to borders of this area to facilitate aeration. Within these boxes, the larvae were maintained until adults emergence. Ten pairs (males + females) of these adults were then housed in a glass cage (30X30X30 cm) provided with a pot planted with bean seedlings infested with the cowpea aphid, *Aphis craccivora*. Moreover, drops of nutritional solution consisting of 1 bee honey:

1 yeast were kept on the lower surface of the cover of this cage as food material for the confined adults. The seedlings were considered as an oviposition site for the predator females. Thus, the pot had to be changed daily. Deposited eggs were collected daily to be used in the following experiments.

2.1. Effect of prey on biological activities

This experiment was conducted under laboratory conditions at 25 $\pm 1^{\circ}$ C, 60% R.H. and 16 L: 8 D photoperiod regime. Three aphid species *i.e., A. gossypii, A. craccivora* and *R. padi* were tested in this experiment. In each case, newly hatched larvae were transferred individually into rearing glass boxes (5 cm high and 7 cm diameter) using a small fine camel-hair brush. For aeration, a circular area of 5 cm diameter was removed from the cover of the box and replaced by muslin cloth glued to borders of this area. The box was bottomed with a disc of filter paper moistened with water drops. One leaf of bean, wheat or a disc from cotton with sufficient number of aphids and one larva of predator were placed on the filter paper disc kept at the bottom of the box. The food material was replaced daily with fresh aphids and one drop of water was added to the filter paper disc. Duration and rate of food consumption were determined for each larval instar until reaching the pupal stage. Rate of larval mortality in all treatments was recorded through 5 replicates, 20 larvae each. Full-grown larvae were provided with a piece of moistened cotton wool in a glass box as a pupation site. Pupae were kept under observation until adults emergence and thus pupal duration was determined for these individuals. Consequently, emergence rates and sex ratios were estimated for the five replicates mentioned above. After adult emergence, in all treatments, each pair (male + female) was kept in a transparent plastic cylinder cage (10 cm high and 7 cm diameter) covered with muslin cloth and placed on a pot planted with one bean seedling infested by *A. craccivora* as an oviposition site. Adults were provided with one drop of nutritional solution (1 yeast: 1 bee honey) which was placed on the internal side of the cylinder. Pots were changed daily and kept to calculate oviposition periods, egg duration and hatchability. Life span of males and females were also calculated for all treatments.

2.2. Effect of temperature on biological characters

Three temperature degrees *i.e.*, 20 ± 1° C, 25 ± 1° C and 30 ± 1° C associated with 60% R.H. were tested. In all treatments, the aphid species, *R. padi* was used as a prey with photoperiod of 16L: 8D. The same technique of the above experiment was followed to study the effect of temperature on the biology of the gall midge.

2.3. Oviposition sites and effect of variable infestation levels on egg laying

Three bean plants (20 cm each) grown in plastic pots were infested with 25, 50 and 100 individuals of *A. craccivora* / plant and the fourth plant had no aphid. These four plants were kept in the same cage (50X50X50 cm), each plant was placed near the angle of the cage. Five mated females (2 days old) were introduced to each cage. This treatment was replicated 5 times. After 2 days, the plants were removed and examined under the light microscope and numbers of eggs deposited on both sides of the leaves, buds and stems were recorded.

2.4. Statistical analysis

Data of all experiments were statistically analyzed using classification one-way MSTAT version 4 (1987). Significant differences among these means were tested by LSD test ($P \leq 0.05$) .

3. RESULTS AND DISCUSSION

3.1. Egg stage

3.1.1. Incubation period

At 25°C, duration of egg stage ranged between 2.45 and 2.75 days according to larval food (aphid species), showing no significant differences among these periods (Table 1). Incubation period decreased gradually with increased temperature where it lasted 3.95 days at 20°C, 2.45 days at 25°C and 1.85 days at 30°C. Moreover, Table (2) shows a significant difference between periods reported for 20°C and both 25°C and 30°C with feeding on *R. padi*. These periods at 20°C and 25°C appear quite similar to those given by Havelka (1980 b) under the same thermal conditions (2.57 and1.67 days, respectively)

Table (1): Effect of prey type (aphid species) on the preimaginal developmental time (days) of *A. aphidimyza* reared at a constant temperature of 25°C.

Stage			*A. craccivora*	*A. gossypii*	*R. padi*
Egg			2.75 a	2.7 a	2.45 a
Larva	First instar		0.93 a	0.98 a	0.88 a
	Second instar		2.13 a	2.48 a	2.48 a
	Third instar		4.05 a	3.85 a	3.7 a
	T.L.P.	Male	6.8	6.7	6.7
		Female	7.4	7.7*	7.4
		Mean	7.1 a	7.2 a	7.05 a
Pupa		Male	6.7	6.8	6.5
		Female	7.2	7.2	6.5
		Mean	6.95 a	7.0 a	6.9 a
Preimaginal development (Total)		Male	16.3	16.3	15.5
		Female	17.3	17.5	17.3*
		Mean	16.8 a	16.9 a	16.4 a

Means followed by the same letter on the same row are not significantly different ($P \leq 0.05$).

*= Significant difference between the two values for male and female ($P \leq 0.05$)

and by Bouchard *et al.* (1981) at 23°C (2 days). However, Havelka and Zemek (1988) stated that the egg duration at the same temperature differs according to the geographic population of this predator. On the other hand, Choi *et al.* (2001) recorded longer periods (4.5, 3.5 and 3 days) under temperatures of 20, 25 and 30°C, respectively. Generally, many authors showed that the incubation period was prolonged

proportionally with decreasing temperatures (Havelka, 1980 b; Morse and Croft, 1987; Nijveldt, 1988; Havelka and Zemek, 1988; Choi *et al.*, 2001).

Table (2): Effect of temperature on the preimaginal developmental time (days) of *A. aphidimyza* feeding on *R. padi.*

Stage			20° C	25° C	30° C
Egg			3.95 a	2.45 b	1.85 b
Larva	First instar		2.35 a	0.88 b	0.78 b
	Second instar		3.2 a	2.48 ab	1.83 b
	Third instar		4.7 a	3.7 b	2.6 c
	T.L.P.	Male	9.8	6.7	4.8
		Female	10.7	7.4	5.8*
		Mean	10.25 a	7.05 b	5.3 c
Pupa		Male	10	6.5	5.4
		Female	11.4*	7.3	5.6
		Mean	10.7 a	6.9 b	5.5 c
Preimaginal development (Total)		Male	23.7	15.5	12.1
		Female	26.1*	17.3*	13.2*
		Mean	24.9 a	16.4 b	12.65 c

Means followed by the same letter on the same row are not significantly different ($P \leq 0.05$)

*= Significant difference between the two values for male and female ($P \leq 0.05$)

3.2. Hatchability

The obtained data indicated that there was no significant effect of various larval preys on hatchability of *A. aphidimyza* eggs, where its rates reached 88% with *A. craccivora*, and 89% with both *A. gossypii* and *R. padi.* Hardly any information is available on the effect of larval food type on egg hatchability of this predator. However, hatching rates were 84, 89 and 87% at 20, 25 and 30° C, respectively, showing no significant differences. These results coincide with those of Havelka (1980 b) who mentioned that hatching rate was increased with increasing temperature from 15° C up to 25° C. Similarly, Morse and Croft (1987) recorded a hatching rate of 89.9% at 24.2° C. Moreover, Havelka and Zemek (1988) stated that the hatchability differs at the same temperature according to the geographic population of the present predator.

3.3. Larval stage

3.3.1. Duration

The present study showed that the larva of *A. aphidimyza* develops through three definite instars, depending on detection of larval exuvia. This number of instars confirms the report of Morse and Croft (1987) and Harris (1973) for this predator. However, Azab *et al.* (1965) recorded four larval instars for the same predator depending only on the body-size and color. Data summarized in Tables (1&2) show that the duration of the larval stadia prolonged with development of the three larval instars. The present study revealed that feeding on the aforementioned aphid species had no effect on the total larval period (Table 1). This period (at 25° C) lasted 7.1 days with *A. craccivora*, 7.2 days with *A. gossypii* and 7.05 days with *R. padi.* However, significant differences were reported for this period due to varied temperatures, being 10.25, 7.05 and 5.3 days at 20, 25 and 30° C, respectively (Table 2). Azab *et al.* (1965) recorded 6 days as a larval duration at 27.8° C with both *A. gossypii* and *A. punicae* , their results coincide with the present values given at 25 and 30° C. Also, Havelka and Zemek (1988) found that the larval development time differs among the geographic populations of this predator even under the same conditions (temperature and prey). In contrast, many authors recorded shorter periods in comparison with the periods reported in the present study; Havelka (1980 b) (7.1 days at 20° C and 5.35 days at

25° C with *Megoura viciae* and *Aphis fabae* together) and Choi *et al.* (2001) (7.3 days at 20° C, 5.3 days at 25° C and 4.3 days at 30 ° C with *M. persicae*). In addition, it appeared that the total larval duration differs according to insect's sex. Under the different temperatures and feeding conditions, this period increased by 0.6 to 1.0 day for the female than for the male (Tables 1&2). No significant differences were noticed between these periods except at 25° C with feeding on *A. gossypii* and at 30° C with feeding on *R. padi* (Tables 1&2).

3.3.2. Feeding capacity

It appeared that the mean feeding capacity of the different larval instars of *A. aphidimyza* increased gradually from the 1st to the 3rd instar in all treatments. Similar findings were recorded by Azab *et al.* (1965); Sell and Kuo-Sell (1987) and Morse and Croft (1987). The mean feeding capacity of the larva differs according to the provided aphid species (Table 3). This capacity significantly varied between feeding on *A. craccivora* (32.05) and both *A. gossypii* (37.25) and *R. padi* (37.45). However, Azab *et al.* (1965) found no significant difference between the number of individuals from both aphid species *A. gossypii* and *A. punicae* consumed by one larva of this predator under the same temperature (27.8°C). *R. padi* consumption increased slightly with increasing temperature from 25°C (37.45 individuals/larva) to 30°C (42.45 individuals/larva),while no difference was shown between the number consumed at 20°C (37.2 individuals/larva) and that at 25°C (Table 4). Choi *et al.* (2001) found that the total consumption of *M. persicae* increased gradually with increasing temperature from 15 up to 30°C. Generally, records reported by previous authors seem to be quite different from those recorded in the present investigation on aphid consumption. Higher records were reported *e.g.*, 60-80 individuals of *A. gossypii* /larva (Roberti, 1946) and 40-60 individuals of *B. brassicae* /larva (George, 1957). Also, lower records were reported *e.g.*, 5.2 large aphids or 14.7 small aphids of *M. persicae* / larva (Nijveldt, 1966), 10 large aphids or 28 small aphids of *M. persicae* /larva (Uygun, 1971) and 5 aphids of *A. pomi*/larva(Olzak,1979).Data presented in Tables(3&4)indicate no significant difference among rates of consumed aphids by male and female larva although the female larva showed a higher rate of consumption than the male in all treatments. A similar result was recorded by Sell and Kuo-Sell (1987).

Table (3): The mean feeding capacity of *A. aphidimyza* larva when fed on different aphid species at a constant temperature of 25° C.

Aphid species	Mean number of aphid individuals consumed by larval stadia			Total consumption	
	1st instar	2nd instar	3rd instar	Male larva Femalel arva	Mean
A. craccivora	2.2 a	8.7 b	21.15 b	30.9 33.2	32.1 a
A. gossypii	3.15 b	9.65 a	24.45 a	35.3 39.2	37.3 a
R.padi	2.9 a	9.6 a	24.95 a	35.8 39.1	37.5 a

Means followed by same letter in the same column are not significantly (P≤0.05)

Table (4): The mean feeding capacity of *A. aphidimyza* larva when fed on *R. padi* at various temperatures.

Temperature °C	Mean numbers of aphid individuals consumed by larval stadia			Total consumption	
	1st instar	2nd instar	3rd instar	Male larva Female larva	Mean
20	5.25 a	8.1 b	22.95a	36.2 38.2	37.2 a
25	2.9 b	9.6 a	24.95 a	35.8 39.1	37.5 a
30	4.1 ab	10.9 a	27.45 a	39.9 45	42.45a

Means followed by same letter in the same column are not significantly (P≤0.05)

3.4. Mortality

Available literature shows that larval mortality rate of this predator differs in the laboratory according to three factors *i.e.*, geographic population, rearing prey and temperature. The predator larvae reared on *R. padi* showed a lower percentage mortality (8%) than on *A. craccivora* (16%) and *A. gossypii* (14%) under the same temperature of 25° C. Havelka and Ruzicka (1984) stated that the percentage mortality of larvae reared on various aphid species did not differ and fluctuated between 13 and 21% at 22° C. The temperature of 30° C induced a higher percentage mortality (22%) than both temperatures of 20° C (11%) and 25° C (8%). Similar results were recorded by Havelka (1980 b) and Havelka and Zemek (1988) where they stated that the mortality of larval stage was higher at 20° C than that at 25° C. However, Havelka and Zemek (1999) recorded high larval mortality in ten geographic populations (35.2 – 73%) at 23° C with feeding on *A. pisum*.

3.5. Pupal stage

Data presented in Table (1) indicate that the aphid species had no effect on pupal duration which was 6.95 days with *A. craccivora*, 7 days with *A. gossypii* and 6.9 days with *R. padi* at 25° C. The duration of pupal stage decreased gradually with increased temperature. A similar observation was recorded by Harris (1973) and Havelka (1980 b). This stage lasted 10.7, 6.9 and 5.5 days at 20, 25 and 30° C, respectively with feeding on the same prey, *R. padi*. Quite similar values were previously recorded by Azab *et al.* (1965) (6-9 days at 27.8° C) and Havelka (1980 b) (10.95 and 7.99 days at 20 and 25° C, respectively). It was noticed that the pupal duration differs according to sex, the difference in pupal durations between the two sexes ranged between 0.2 and 1.4 day (Tables 1&2) with a significant difference only between male and female pupal durations for pupae produced from larvae fed on *R. padi* at 20° C.

3.6.Total preimaginal duration

The aphid species (at 25° C) had no significant effect on the total duration of preimaginal stages (Table 1). The total preimaginal development periods were 16.4 days with *A. craccivora*, 16.9 days

with *A. gossypii* and 16.4 days with *R. padi*. No information is available about the effect of aphid species (as a larval food) on the total developmental period of preimaginal stages of this predator. This period was longer with decreasing temperature, it lasted 24.9, 16.4 and 12.65 days at 20, 25 and 30° C, respectively (Table 2). Havelka and Zemek (1988 and 1999) found that the total development period at 23 - 25° C ranged between 14 and 17 days according to the geographic population. Data in Tables (1&2) indicated that the total developmental period was longer in the case of females than in males. The difference between both sexes in total preimaginal development ranged between 1 and 2.4 days. A similar finding was recorded by Uygun (1971) who mentioned that the males emerge 1 day before the females.

3.7. Rate of adult emergence

Aphid species as a larval food had no effect on adult emergence rate (at 25° C), where it was 91.9% with *A. craccivora*, 92% with *A. gossypii* and 92.5% with *R. padi*. A coincident result was recorded by Kuo-Sell (1989) who stated that the rate of adult emergence was the same when feeding on the cereal aphid, *R. padi* or the green peach aphid, *M. persicae*. On the other hand, adult emergence rate was much affected by temperature, where this rate reached 89, 92.5 and 78.4% at 20, 25 and 30° C, respectively. However, Havelka (1980 a) determined the adult emergence rate by 91.5% at 25° C.

3.8. Adult stage

3.8.1. Sex ratio

In the present investigation neither aphid species nor temperature seemed to have a clear effect on sex ratio of *A. aphidimyza*. The sex ratios (females %) fluctuated between 51.74 and 52.66% in the various aforementioned treatments giving a final sex ratio of 52.1% (1 male: 1.06 females). Similar ratios were reported for this predator by Sell (1976) and Heimpel and Lundgren (2000) (1: 1). Moreover, Havelka and Zemek (1999) mentioned that the sex ratio differed according to the geographic population, where a range of 47 to 72% females was recorded for ten geographic populations of this predator.

3.8.2. Adult longevity

Longevity of males or females did not differ according to larval feeding on the various aphid species. A similar finding was recorded by Sell and Kuo-Sell (1987). However, Kuo (1977) stated that the host plants of aphids, *M. persicae* seem to have an effect on adult longevity. The male longevities at 25° C were 4.8, 4.2 and 5 days while the female longevities extended to 8.1, 8.6 and 8.7 days with larval feeding on *A. craccivora*, *A. gossypii* and *R. padi*, respectively (Table 5). This range of female longevity matches with that recorded by Choi *et al.* (2001) (8.9 days at 25° C), while they recorded a longer male longevity (6.8 days) than that recorded in the present study. Azab *et al.* (1965) recorded shorter period (2-3 days) for adult longevity at 27.8° C associated with larvae fed on *A. gossypii* or *A. punicae*. Moreover, Havelka and Zemek (1999) pointed out that the adult longevity differed according to the geographic population of the predator. On the other hand, temperature has an obvious effect on adult longevity where it decreased gradually in both sexes with increasing temperatures from 20 up to 30° C. Male longevities were 5.5 and 2.2 days while that of females extended to 12.4 and 5 days at 20 and 25° C, respectively (Table 6).At present there is no available literature about the effect of temperature on adult longevity of *A. aphidimyza*. Regardless of temperature and larval food type, longevity of males was always shorter than that of females (Tables 5&6). Similar findings were recorded by Uygun (1971), Harris (1973), Nijveldt (1988), Sell and Kuo-Sell (1987) and Choi *et al.* (2001).

3.8.3. Oviposition periods

The preoviposition period did not differ according to larval food type at temperature of 25° C, it lasted 1.7 days with larval feeding on *A. gossypii* and *R. padi*, and 1.8 days with *A. craccivora* (Table 5). However, this period decreased gradually due to an increase of temperature; being 2.2 and 1.3 days at temperatures of 20 and 30° C, respectively (Table 6). Havelka and Zemek (1999) found that the females started to lay their eggs on the second day after mating at 23° C. Meanwhile, Choi *et al.* (2001) recorded 2.3 days for this period at 25° C with larval feeding on *M. persicae*.

The oviposition period in tested females did not differ according to larval food type at25°C;lasting 6.3, 6.9 and 7days with *A. craccivora*

A. gossypii and *R. padi* as a larval prey, respectively (Table 5). On the other hand, this period differed significantly according to temperature (Table 6), where it lasted 9.9 and 3.7 days at 20 and 30° C, respectively. On the contrary, Havelka and Ruzicka (1984) reported 16 days for oviposition period at 22° C with the aphid, *Acyrthosiphum pisum*.

No postoviposition period was reported for all treatments except that associated with females reared at 20° C where it lasted 0.6 day.

Table (5): Adult longevity and oviposition periods (Days) of *A. aphidimyza* with larval feeding on different aphid species at 25° C.

Aphid species	Longevity		Oviposition periods		
	Male	Female	Preoviposition	Oviposition	Postoviposition
A. craccivora	4.8 a	8.1 a	1.8 a	6.3 a	0
A. gossypii	4.2 a	8.6 a	1.7 a	6.9 a	0
R. padi	5.0 a	8.7 a	2.2 a	7.0 a	0

Means followed by the same letter in the same column are not significantly different (P≤0.05).

Table (6): Effect of temperature on adult longevity and oviposition periods (Days) of *A. aphidimyza* with larval feeding on *R. padi*.

Temperature C°	Longevity		Oviposition periods		
20	5.5a	12.4a	2.2a	9.9a	0.6
50	5.0a	8.7b	1.7b	7.0b	0
30	2.2b	5.0c	1.3b	3.7c	0

Means followed by the same letter in the same column are not significantly different (P≤0.05).

3.8.4.Fecundity

The mean number of eggs laid by females produced from larvae reared on *A.craccivora* (73.4 eggs/female) was lower than that produced from larvae reared on *A. gossypii* (91.9 eggs/female) or *R. padi* (85.8 eggs/female). Kuo-Sell (1989) reported a higher fecundity

rate for females produced from larvae fed on *R. padi* than for those produced from larvae fed on the three other aphid species. The temperature of 30° C was associated with a lower number of eggs (56.9 eggs/female) than that recorded at 25° C (85.8 eggs/female), while egg productivity at 20° C (82.5 egg/female) did not differ significantly from that recorded at 25° C. However, a range from 70 to 110 total eggs laid by *A. aphidimyza* female was recorded by different authors, *e. g.*, Uygun, 1971 (70 eggs); Kuo, 1977 (76 – 98.8 eggs); Havelka and Ruzicka, 1984 (80-110 eggs); Gilkeson and Hill, 1986 (98.5-109.4 eggs in 1983) and Choi *et al.*, 2001 (105.3 eggs). However, Gilkeson (1987) recorded a total fecundity of 154.3 and 248.6 eggs/female in two separate experiments. Moreover, Havelka and Zemek (1999) recorded a total fecundity ranging from 48 to 148 eggs/female among ten geographic populations for the predator under investigation.

3.8.5. Egg laying behaviour

3.8.5.1. Oviposition sites

It was noticed that *A. aphidimyza* females prefer to lay most of their eggs on the lower surface of the bean leaves (72.15% of total eggs). Meanwhile, very few eggs were laid on the upper surface of the leaves (2.4%). The mean percentages of eggs laid by females on buds and stems were 16.7 and 8.8%, respectively. A coincident result was recorded by Mansour (1975). Most aphid species predominantly colonized on the lower surface of the plant leaves. Therefore, the behaviour of the *Aphidoletes* females is well adapted to the aphid behaviour (Mansour, 1976). *Aphidoletes* females laid their eggs singly or in groups of 2 or 3 eggs each at most. A similar finding was recorded by Azab *et al.* (1965), while Harris (1973) mentioned that some eggs were laid in clusters of up to 40 eggs. Moreover, some eggs were deposited directly on the aphids; a similar observation was reported by Harris (1973).

3.8.5.2. Effect of aphid density

It appeared that the mean percentage of deposited eggs decreased gradually with decreasing aphid density from 100 individuals / plant to plants without aphids. These percentages were 67.5, 24.5, 7.5 and 0.5% for the plants colonized by 100, 50,25 aphids/

plant and plants without aphids, respectively. Miesner (1975) observed that prey odour attracted *Aphidoletes* females to lay their eggs among aphid colonies. According to Uygun (1971) and El-Titi (1972-1973), no eggs were laid in the absence of aphids. The presence of aphids near the eggs ensures that despite a low searching capacity, the newly hatched larva can find its prey (Wilbert, 1973).

4. REFERENCES

Azab A.K.,Tawfik M.F.S. and Ismail I. I.(1965). Morphology and biology of the aphidophagous midge, *Phenobremia aphidivora* Rübsaamen. Bulletin of Entomological Society of Egypt. 49, 25-45.

Bouchard D., Tourneur J.C. and Paradis R.O. (1981). Bio-écologie d'*Aphidoletes aphidimyza* (Rondani) (Diptera : Cecidomyidae) prédateur du puceron du pommier, *Aphis pomi* DeGreer (Homoptera : Aphididae). Annales de la Société Entomologique du Quebec. 26 (2), 119-130.

Choi M.Y.,Paik G.H. and Kim D.H. (2001). Development and predition of aphidophagous gall midge, *Aphidoletes aphidimyza* (Rondani) (Diptera : Cecidomyiidae) on *Myzus persicae* Sulzer. Korean J. Appl. Entomol. 40 (1), 45-49.

El-Titi A. (1972-73). Einflusse von Beutedichte und Morphologie der Wirtspflanze auf die Eiablage von *Aphidoletes aphidimyza* Rond. Z. Angew. Entomol. 72, 400-415.

George K.S. (1957). Preliminary investigations on the biology and ecology of the parasites and predators of *Brevicoryne brassicae* (L.). Bulletin of Entomological Research. 48, 619-629.

Gilkeson L.A. (1987). A note on fecundity of the aphid predator, *Aphidoletes aphidimyza* (Rondani) (Diptera: Cecidomyiidae). Canadian Entomologist. 119 (12), 1145-1146.

Gilkeson L.A. and HillS.B. (1986). Genetic selection for an evaluation of nondiapause lines of predatory midge, *Aphidoletes aphidimyza* (Rondani) (Diptera: Cecidomyiidae). Canadian Entomologist. 118(9), 869-879.

Harris K.M.(1973). Aphidophagous Cecidomyiidae (Diptera): taxonomy, biology and assessments of field populations. Bulletin Ent. Res. 63, 305-325.

Havelka J. (1980 a). Some aspects of photoperiodism of the aphidophagous gall midge *Aphidoletes aphidimyza* (Rond.). SROP/WPRS Bulletin. 1980/III/3, 75-81.

Havelka J. (1980 b). Effect of temperature on the developmental rate of preimaginal stages of *Aphidoletes aphidimyza* (Diptera, Cecidomyiidae). Entomol. Exp. Appl. 27 (1), 83-90.

Havelka J. and Ruzicka Z.(1984). Selection of aphid species by ovipositing females and effects of larval food on the development and fecundity in *Aphidoletes aphidimyza* (Rondani) (Diptera, Cecidomyiidae). Zeitschrift für angewandte Entomologie. 98 (5), 432-437.

Havelka J. and Zemek R. (1988). Intraspecific variability of aphidophagous gall midge, *Aphidoletes aphidimyza* Rondani (Diptera, Cecidomyiidae) and its importance for biological control of aphids. 1. Ecological and morphological characteristics of populations. J. Appl. Ent. 105, 280-288.

Havelka J. and Zemek R. (1999). Life table parameters and oviposition dynamics of various populations of the predacious gall- midge *Aphidoletes aphidimyza*. Entomologia Experimentalis et Applicata. 91, 481-484.

Heimpel G. E. and Lundgren J. G. (2000). Commentary: Sex ratios of commercially reared biological control agents. Biological Control. 19, 77 – 93.

Ismail I. I. (1963). Population studies on some aphids and their predators in Giza region together with the external morphology and biology of *Phenobremia aphidivora* Rubsaamen (Cecidomyiidae: Diptera). M. Sc. Thesis, Faculty of Agriculture, Cairo University. 189 pp.

Krivan V. and Havelka J.(2000). Leslie model for predatory gall-midge population. Ecological modelling. 126, 73-77.

Kuo H.L. (1977). Auswirkungen zweier wirtspflanzen von *Myzus persicae* (Sulz.) auf den räuberischen Blattlausfeind *Aphidoletes aphidimyza* (Rond.) (Diptera: Cecidomyiidae). Zeitschrift für Angewandte Entomologie. 82 (3), 229-233.

Kuo-Sell H.L.(1989). Cereal aphids as prey species for mass rearing of *Aphidoletes aphidimyza* (Rond.) in the biological control of *Myzus persicae* (Sulz.) in greenhouses. J. Appl. Ent. 107, 58-64.

Mansour M. H.(1975). The role of plants as a factor affecting oviposition by *Aphidoletes aphidimyza* (Diptera : Cecidomyiidae). Entomol. Exp. Appl. 18 (2), 173-179.

Mansour M.H. (1976). Some factors influencing egg laying and site of oviposition by *Aphidoletes aphidimyza* (Dipt: Cecidomyiidae). Entomophaga. 21 (3), 281-288.

Markkula M. and Tiittanen K.(1985). Biology of the midge *Aphidoletes* and its potential for biological pest control, the glasshouse experience. 240 pp. Edited by Hussey, N.W. and N.E.A. scopes. Publisher: Blandford press, UK. 74-81.

Miesner H.(1975). Einfluss unterchiedlicher Beuteverteilung auf den Sucherfolg von *Aphidoletes aphidimyza* Rond. (Cecidomyiidae). Diss. Landw. Fak. Universität Göttingen.

Morse J.C. and Croft B.A. (1987). Biological control of *Aphis pomi* (Hom.: aphididae) of *Aphidoletes aphidimyza* (Dip.: Cecidomyiidae): a predator–prey model. Entomophaga. 32 (4), 339-356.

MSTAT Version 4 (1987). Software program for the design and analysis of agronomic research experiments. Michigan St. Univ., M. S., U.S.A.

Nijveldt W.(1966). The food necessity of *Phaenobremia aphidimyza* (Rondani) (Diptera: Cecidomyiidae). Cecidologica Indica. 1(3), 185-187.

Nijveldt W. (1988). Cecidomyiidae. In: Aphids: their biology, natural enemies and control. World Crop Pests, volume 2 B, 364 pp. Edited by Minks, A.K. and P. Harrewijn. 271-278.

Olszak R. (1979). Occurrence of gall midges (Diptera, Cecidomyiidae) in aphid colonies on apple trees. (poln.) Polskie Pismo Entomologiczne. 49 (1), 185-195.

Roberti D. (1946). *Phenobremia aphidimyza* (Rond.) (Diptera : Cecidomyiidae), ein Prädator von *Aphis frangulae* Koch. (ital.) Bolletino dell'Instituto di Entomologia della Universita degli Studi di Bologna. 15, 233-256.

Sell P.(1976). Monogenie bei *Aphidoletes aphidimyza* (Rond.) (Diptera: Cecidomyiidae). Zeitschrift für Angewandte Entomologie. 82 (1), 58-61.

Sell P. and Kuo-Sell, H.L.(1987). Leistungsfähigkeit der aphidophagen Gallmücke *Aphidoletes aphidimyza* (Rond.) (Diptera,

Cecidomyiidae) on Abhängigkeit von verschiedenen Einflubssfaktoren. Zeitschrift für Angew. Entomol. 103, 434-447.

Uygun N. (1971). Der Einflub der Nahrungsmenge auf Fruchtbarkeit und Lebensdauer von *Aphidoletes aphidimyza* (Rond.) (Diptera, Itonididae). Zeitschrift für Angewandte Entomologie. 69 (3), 234-258.

Wilbert H. (1973). Zur Suchfähigkeit der Eilarven von *Aphidoletes aphidimyza* (Rond.) (Cecidomyiidae). Entomol. Exp. Appl. 16, 514-524.

Wood-Baker C. S. (1965). Aphidovorous Cecidomyiidae (Diptera), an investigation of the occurrence and bionomics of aphid-eating gall-midges, mainly in Britain. Entomologist's Monthly Magazine. 100, 212-231.

النشاطات البيولوجية للسلالة الجغرافية المصرية للهاموش المفترس *Aphidoletes aphidimyza* (عائلة Cecidomyiidae: رتبة ذات الجناحين)

سامي محمود حامد سيد، سيد أشرف الأرناؤوطى

قسم الحشرات الاقتصادية والمبيدات – كلية الزراعة – جامعة القاهرة– الجيزة

ملخص

أجريت دراسة للنشاطات البيولوجية للمفترس *Aphidoletes aphidimyza* باستخدام ثلاث أنواع من المن (من القطن *Aphis gossypii* ، من البقوليات *Aphis craccivora* ومن النجيليات *Rhopalosiphum padi*) تحت ظروف درجة حرارة ٢٥ ± ١ م ، ٦٠% رطوبة نسبية وفترة إضاءة : إظلام (١٦:٨ ساعة) .

كذلك تمت دراسة تأثير درجات الحرارة ٢٠ و ٣٠ م على نفس النشاطات البيولوجية تحت نفس الظروف الأخرى وبالتغذية على من النجيليات. لم تتأثر فترة الحضانة و نسبة الفقس للبيض بنوع التغذية لليرقات، ولكنهما انخفضتا بزيادة درجة الحرارة. وقد سجل لليرقة ثلاث أعمار انسلاخية بالاعتماد على مشاهدة جلود الانسلاخ لليرقة. تزيد هذه الأعمار في مدتها تدريجيا من العمر الأول إلى

العمر الثالث وكذلك في استهلاكها لأفراد المنّ في جميع المعاملات .

إتضح عدم وجود تأثيرا لنوع غذاء اليرقة على مدة طوري اليرقة والعذراء وكذلك المدة الكلية للأطوار غير الكاملة ولكن انخفضت بزيادة درجة الحرارة. تراوحت الكفاءة الإفتراسية لليرقات بين ٣٢,٠٥ إلى ٣٧,٤٥ فرد منّ/يرقة على ٢٥°م ولكن على ٣٠°م بلغت هذه الكفاءة ٤٢,٤٥ فرد منّ/يرقة . استهلكت يرقات الإناث عدد أكبر من الفرائس عن يرقات الذكور. ظهرت أقل نسبة موت لليرقات عند التغذية على منّ النجيليات على ٢٥°م (٨%). كما اتضح أن المدة الكلية للأطوار غير الكاملة تقل في الذكور عن الإناث بحوالي ١ إلى ٢,٤ يوم مما يوضح أن الذكور تخرج مبكراً عن الإناث .

لم تتأثر نسبة خروج الحشرات الكاملة بنوع تغذية اليرقات حيث بلغت هذه النسبة ٩١,٨٨ إلى ٩٢,٤٨% ولكن تأثرت هذه النسبة بدرجات الحرارة حيث كانت ٨٩,٠٤ و ٧٨,٣٦ % على درجات حرارة ٢٠ و ٣٠°م ،على التوالي. لم يؤثر نوع تغذية اليرقات وكذلك درجات الحرارة في النسبة الجنسية حيث كان متوسطها لجميع المعاملات ٥٢,١ % إناث (١ ذكر : ١,٠٦ إناث).

لم يؤثر نوع غذاء اليرقات على كل من مدة حياة الذكور والإناث، في حين أثرت درجات الحرارة على تلك الفترات حيث قلت مدة كليهما بزيادة درجة الحرارة، وكانت فترة حياة الذكور أقصر دائماً من فترة حياة الإناث .كانت الخصوبة (كفاءة وضع البيض) للإناث الناتجة من التغذية على منّ القطن (٩١,٩ بيضة/أنثى) ومنّ النجيليات (٨٥,٨ بيضة/أنثى) على درجة حرارة ٢٥°م عالية عما فى حالة الإناث الناتجة من التغذية على منّ البقوليات (٧٣،٤ بيضة/أنثى). لم يختلف تأثير درجة الحرارة ٢٠°م (٨٢,٥ بيضة/أنثى) عن تأثير ٢٥°م في حين قلت هذه الكفاءة على ٣٠°م (٥٦,٩ بيضة/أنثى) .

أظهرت النتائج أن إناث المفترس تفضل السطح السفلي عن العلوي لأوراق النبات لوضع البيض عليه حيث وضعت حوالي ٧٢,١٥% من العدد الكلى للبيض على هذا السطح. وقد إنجذبت الإناث إلى النباتات المصابة بكثافة عالية من المنّ. لذلك تقترح الدراسة الحالية استخدام منّ النجيليات ودرجة الحرارة ٢٥°م لتربية مفترس المنّ *A. aphidimyza* .