

## On the biology of the peach aphid, *Brachycaudus (Appelia) schwartzi* (Borner) and its parasitoid, *Aphidius matricariae* (Hal.) (Hymenoptera: Aphidiidae)

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### ABSTRACT

Biology of the peach aphid species, *Brachycaudus (Appelia) schwartzi* (Borner) (Homoptera: Aphididae) and its parasitoid, *Aphidius matricariae* (Hal.) (Hymenoptera: Aphidiidae) was studied under laboratory conditions. Results showed an inverse relationship between temperature and duration of immature stages, longevity, fecundity and mortality rate of *B. schwartzi* i.e. durations of total nymphal instars decreased from 18.55±0.61 at 15 °C to 5.42±0.87 days at 30 °C and longevity decreased from 16.86±0.65 at 15 °C to 3.5±0.36 days at 30 °C. The same trend was obtained for fecundity and mortality rates. Studied biological parameters of the parasitoid, *A. matricariae* when parasitized *B. schwartzi* showed that the developmental periods of the stages; egg-mummy, mummy-adult and egg-adult attained 6.44±0.5, 4.32±0.47 and 10.76±0.43 days at 25±0.5°C, 65±5% R.H. and 14:10 L:D photophase. Results also showed a significant correlation between adult longevity and feeding as well between fecundity and female age. Parasitism during the 2<sup>nd</sup> day of the female gave highest significant mean numbers of mummies and adult emergence rates.

**Key Words:** Biology, Peach aphid, *Brachycaudus (Appelia) schwartzi*, *Aphidius matricariae*.

### INTRODUCTION

Peach (*Prunus persicae*) is among the most important economic fruit crops in North Sinai Governorate, it occupied about 60446 (62.8 %) feddans from the cultivated area of fruit crops in the region (96306 feddans) in year 2007 (Statement of the Directorate of Agriculture in Northern Sinai). It is constrained by a variety of insect pests and diseases. Aphids (Homoptera: Aphididae) are the serious insect pests attacking peach trees. Aphids are also efficient vectors of different strains of plant viruses. *Brachycaudus (Appelia) schwartzi* (Borner) was recorded earlier on peach trees (Attia and El-Hamaky, 1992). Occurrence period of *B. schwartzi* extended from early Feb. until early June, 432.0 aphids/40 leaves were recorded by the 4<sup>th</sup> week of May and 802.0 aphids/40 leaves in the 4<sup>th</sup> week of April in 2005 and 2006 seasons, respectively (El-Deeb, 2008).

*Aphidius matricariae* (Hal.) is one of the key primary parasitoid species of aphids in the Middle East region which has a quite wide host range (Stary, 1976). This parasitoid species was recorded on *B. schwartzi* in North Sinai during the study of El-Deeb, 2008.

The biology can offer quantitative estimates of life history parameters that help interpreting the population dynamics and productivity to make effective management decisions for aphid species and their associated parasitoids on peach trees.

Contributing to the importance of the aphid parasitoids, in particular *A. matricariae* and their economic hosts, the present study dealt with some biological parameters of both the peach aphid, *B. schwartzi* and its parasitoid, *A. matricariae* under laboratory conditions.

### MATERIALS AND METHODS

#### Laboratory cultures:

Laboratory cultures of the aphid, *B. schwartzi* and the parasitoid, *A. matricariae* were established at the Entomology laboratory, Plant Production Department., Faculty of Environmental Agricultural Sciences, at El-Arish.

A stock culture of *B. schwartzi* was initiated by using aphid specimens of apterous females collected from infested peach leaves (*Prunus persicae*) from the district of Rafah, North Sinai Governorate, Egypt. The aphid colony was maintained on peach twigs in small plastic pots (12 × 12) cm<sup>3</sup> including solution of sugar and salicylic acid. They were changed every two days, in small glass cages under the laboratory conditions 25 ± 1° C and 65 ± 5 % R.H and photoperiod L:D 14:10. The culture was maintained by adding fresh twigs

infested with *B. schwartzi*. Infested twigs with the aphid species were kept under daily observation to establish pure culture.

Mummies of *A. matricariae* were obtained from the Biological Control Department, PPRI, ARC, at Giza, and observed till adults' emergence. Males and females of *A. matricariae* were allowed to mate in small glass vials and provided with droplets of honey as food. The techniques described by Adly (2002) were followed to carry out biological studies on the parasitoid.

### **Biological experiments:**

#### **a- *Brachycaudus schwartzi***

Biological studies were carried out on *B. schwartzi* reared on fresh peach leaves collected from twigs kept in a solution of sugar and aspirin. Fifty apterae viviparous *B. schwartzi* females of the same age were chosen from the aphid culture to be placed on the twigs. Forty newly deposited nymphs were collected to ensure the homogeneity of age of the new generation. Each nymph was kept in a 10 cm diameter Petri dish covered with muslin cloth. In each Petri dish, the nymph was placed on a fresh leaf, covered with another leaf to restrict its movement.

Newly nymphs were placed individually in sterilized Petri dishes (40 dishes) as one nymph/ dish, put in an incubator on each of the temperature degrees, 15, 25 and  $30 \pm 0.5^\circ \text{C}$ .

Nymphs' durations, pre- parturition & parturition periods, number of progeny/female and post parturition period and mortality% were recorded.

Duration of each nymphal instar, adult longevity and adult fecundity were deduced at each tested temperature degrees (Adly 2002).

#### **b- *Aphidius maricariae***

##### **Life cycle**

Twenty-five nymphs, almost 2<sup>nd</sup> and 3<sup>rd</sup> nymphal instars from *B. schwartzi* were placed on peach twigs, cultivated in small pots and kept in small glass cages (25 replicates) individually under the laboratory conditions  $25 \pm 1^\circ \text{C}$ ,  $65 \pm 5\%$  R.H and photoperiod L:D 14:10. In each cage, aphids were exposed to one mated female for six hours then the parasitoid females were removed, and then the cages were placed under laboratory conditions to determine the durations of different parasitoid stages (egg-mummy, mummy-adult and egg-adult), % of emergence and sex ratio.

##### **Effect of food on adult longevity**

Sixty newly emerged adults (30 females and 30 males) of the parasitoid were placed individually in small glass vials containing droplets of honey. In the other experiment, the same number of females and males of the parasitoid were placed individually without food (starved) until death to study the influence of feeding on adult longevity.

##### **Influence of parasitoid female age on fecundity**

Four hundred nymphs, almost 2<sup>nd</sup> and 3<sup>rd</sup> nymphal instars from *B. schwartzi* were placed on peach twigs, divided into 20 replicates; each contained 20 nymphs of aphids. In each replicate, aphids were exposed to one mated female for one day. Afterwards, parasitoid females were removed daily to another 20 nymphs and so on until death of the parasitoid females. All replicates were placed under laboratory conditions to determine mean no. of mummies, mean numbers of adult emerged, percentage emergence, sex ratio and consequently influence of different ages on parasitism.

Data were statistically analyzed using costat computer program for comparing the difference among means.

## **RESULTS AND DISCUSSION**

### **1- Biology of *Brachycaudus schwartzi***

Life cycle parameters of *B. schwartzi* on peach twigs under the laboratory conditions of  $15 \pm 0.5$ ,  $25 \pm 0.5$  and  $30 \pm 0.5^\circ \text{C}$  and 60-70% R.H. %, and photoperiod L:D 14:10 are presented in table (1).

#### **1-1-Durations of immature stages**

##### **1-1-1- First nymphal instar**

The mean duration of the first instar was  $3.93 \pm 0.37$ ,  $1.21 \pm 0.25$  and  $1.22 \pm 0.25$  days at 15, 25 and  $30^\circ \text{C}$ ,

Table (1): Effect of temperature on some biological parameters (mean  $\pm$  SD) of the peach aphid *Brachycaudus schwartzi* under 60-70% R.H. %, and photoperiod L:D 14:10 (N = 40).

Parameters	Temperature			LSD <sub>0.05</sub>	
	15 °C	25 °C	30 °C		
First nymphal instar	3.93 $\pm$ 0.37 <sup>a</sup>	1.21 $\pm$ 0.25 <sup>b</sup>	1.22 $\pm$ 0.25 <sup>b</sup>	0.141	
Mortality %	5	7	12.5		
Second nymphal instar	4.98 $\pm$ 0.35 <sup>a</sup>	2.11 $\pm$ 0.21 <sup>b</sup>	1.19 $\pm$ 0.24 <sup>c</sup>	0.140	
Mortality %	7	5	11.4		
Third nymphal instar	5.36 $\pm$ 0.28 <sup>a</sup>	1.98 $\pm$ 0.23 <sup>b</sup>	1.62 $\pm$ 0.21 <sup>c</sup>	0.129	
Mortality %	2	5	6		
Fourth nymphal instar	4.26 $\pm$ 0.28 <sup>a</sup>	1.68 $\pm$ 0.24 <sup>b</sup>	1.37 $\pm$ 0.29 <sup>c</sup>	0.144	
Mortality %	-	-	3		
Total nymphal period	18.55 $\pm$ 0.61 <sup>a</sup>	7.01 $\pm$ 0.44 <sup>b</sup>	5.42 $\pm$ 0.50 <sup>c</sup>	0.279	
Pre- parturition period	1.89 $\pm$ 0.24 <sup>a</sup>	0.62 $\pm$ 0.21 <sup>b</sup>	0.56 $\pm$ 0.16 <sup>b</sup>	0.121	
Mortality %	5	3	10		
Parturition period	10.01 $\pm$ 0.44 <sup>a</sup>	2.62 $\pm$ 0.31 <sup>b</sup>	2.1 $\pm$ 0.20 <sup>c</sup>	0.194	
Post- parturition period	5.03 $\pm$ 0.40 <sup>a</sup>	1.60 $\pm$ 0.32 <sup>b</sup>	0.84 $\pm$ 0.23 <sup>c</sup>	0.188	
Longevity	16.93 $\pm$ 0.60 <sup>a</sup>	4.85 $\pm$ 0.44 <sup>b</sup>	3.5 $\pm$ 0.38 <sup>c</sup>	0.277	
Life cycle	35.53 $\pm$ 0.81 <sup>a</sup>	11.87 $\pm$ 0.70 <sup>b</sup>	8.9 $\pm$ 0.55 <sup>c</sup>	0.399	
Fecundity	Total	40.34 $\pm$ 1.99 <sup>a</sup>	25.25 $\pm$ 1.83 <sup>b</sup>	11.04 $\pm$ 1.76 <sup>c</sup>	1.050
	Nymphs/female/day	4.03 $\pm$ 0.29 <sup>c</sup>	9.77 $\pm$ 1.50 <sup>a</sup>	5.29 $\pm$ 0.94 <sup>b</sup>	0.588

respectively. Respective mortality rates were 5, 7 and 12.5%. At 15 °C, there was a significant prolongation in the duration of the 1<sup>st</sup> instar compared to the 25 and 30 °C,. Mortality rate was low (5%) at 15 °C and increased significantly to 12.5% at 30 °C.

#### 1-1-2- Second nymphal instar

The mean duration of the second instar was 4.98  $\pm$  0.35, 2.11  $\pm$  0.21 and 1.19  $\pm$  0.24 days at 15, 25 and 30 °C, respectively. Respective mortality rates were 7, 5 and 11.4%.

#### 1-1-3- Third nymphal instar

The average duration of the third instar was 5.36  $\pm$  0.28, 1.98  $\pm$  0.23 and 1.62  $\pm$  0.21 days at the 3 temperature degrees, respectively. Respective mortality rates were 2, 5 and 6%.

#### 1-1-4- Fourth nymphal instar

The average duration of the fourth instar was 4.26  $\pm$  0.28, 1.68  $\pm$  0.24 and 1.37  $\pm$  0.29 days at 15, 25 and 30 °C, respectively. Respective mortality rates were 0, 0 and 3%.

#### 1-1-5- Total nymphal period

The mean durations of the nymphal period were 18.55  $\pm$  0.61, 7.01  $\pm$  0.44 and 5.42  $\pm$  0.50 days at 15, 25 and 30 °C, respectively.

There were significant reductions in the mean durations of 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> nymphal instars by increasing the temperature and an inverse relationship was found between temperature and duration. Also, there was a significant reduction in the average duration of total nymphal period by increasing the temperature.

The present results agree with the findings of Bueno and Foureaux (1997) on *B. schwartzi*.

#### 1-2-Parturition periods

As shown in table (1), the average durations of the pre-parturition period were 1.89  $\pm$  0.24, 0.62  $\pm$  0.21 and 0.56  $\pm$  0.16 days at 15, 25 and 30 °C, respectively. Respective mortality rates were 5, 3 and 10%. The mean durations of parturition period were 10.01  $\pm$  0.44, 2.62  $\pm$  0.31 and 2.1  $\pm$  0.20 days at 15, 25 and 30 °C, respectively;. The average durations of the post parturition period were 5.03  $\pm$  0.40, 1.60  $\pm$  0.32 and 0.84  $\pm$  0.23 days at 15, 25 and 30 °C, respectively.

#### 1-3-Longevity

As shown in table (1), the average durations of adult longevity were 16.93  $\pm$  0.60, 4.85  $\pm$  0.44 and 3.5  $\pm$  0.38 days at 15, 25 and 30 °C, respectively. In the same trend, there was a significant reduction in the

mean durations of the pre- parturition, parturition, and post parturition and longevity periods by increasing the temperature.

#### 1-4- Life cycle

As shown in table (1), the mean durations of the life cycle were  $35.53 \pm 0.81$ ,  $11.87 \pm 0.70$  and  $8.9 \pm 0.55$  days at 15, 25 and 30 °C, respectively. Also, there was a significant reduction in the average duration of the life cycle period by increasing the temperature.

#### 1-5- Fecundity

The means of total numbers of offspring deposited per viviparous female were  $40.34 \pm 1.99$ ,  $25.25 \pm 1.83$  and  $11.04 \pm 1.76$  nymphs at 15, 25 and 30° C, respectively. The mean reproductive rate of nymphs/female/day was  $4.03 \pm 0.29$ ,  $9.77 \pm 1.48$  and  $5.29 \pm 0.94$ , respectively.

These results agree with the findings of Bueno and Foureaux (1997) and Satar and Yokomi (2002) on *B. schwartzi*.

### 2-Biology of the aphid parasitoid, *Aphidius matricariae* (Hal.)

Present data included developmental periods, % adult emergence, sex ratio and also the effect of feeding on adult longevity and influence of female age on fecundity.

#### 2-1- Developmental periods

The mean periods of egg-mummy, mummy - adult and egg-adult of *A. matricariae* when parasitized *B. schwartzi* under the lab. conditions of  $25 \pm 1$  °C,  $65 \pm 5$  % R.H and photoperiod L:D 14:10 are shown in table (2) as  $6.44 \pm 0.50$ ,  $4.32 \pm 0.47$  and  $10.76 \pm 0.43$  days, respectively.

The first mummy was formed after an average period of  $6.44 \pm 0.50$  days, while the last one was found after  $7.8 \pm 0.5$  days. The first parasitoid adult emerged after an average period of  $10.76 \pm 0.34$  days, while the last one emerged after  $12.12 \pm 0.6$  days. Percentage of emergence was estimated by  $91.45 \pm 5.9$  %, with a sex ratio of 1.76:1 females/male (Table2).

#### 2-2- Effect of feeding on adult longevity of *A. matricariae*

Data presented show that the influence of feeding with droplets of honey on the longevity of adults was significant on both females and males. Longevities were  $4.53 \pm 0.34$  and  $3.33 \pm 0.35$  days, respectively; when they fed on the honey compared to  $3.4 \pm 0.35$  and  $2.65 \pm 0.35$  days, for unfed adults.

#### 2-3- Influence of female age on parasitism and fecundity

Fecundity of *A. matricariae* on *B. schwartzi* for a sequence of 4 days (average female longevity) for the same female, was estimated at  $25 \pm 1$  °C,  $65 \pm 5$ % R.H% and photoperiod L:D 14:10. Obtained data presented in table (3) showed that in case of the first day, mean numbers of mummies and emerged adults, percentage of emergence and sex ratio reached  $10.25 \pm 0.96$ ,  $8.15 \pm 1.30$ ,  $75.17 \pm 20.11$ % and 0.49:1, respectively. In case of the second day, these were  $14.45 \pm 0.60$ ,  $13.02 \pm 1.05$ ,  $91.45 \pm 7.49$  % and 1.65:1, respectively. In case of the third day, these were  $9.5 \pm 0.94$ ,  $8.05 \pm 0.88$ ,  $84.84 \pm 5.80$  % and 1.8:1, respectively. In case of the fourth day, correspondent values were  $4.45 \pm 0.68$ ,  $3 \pm 0.64$ ,  $67.83 \pm 13.01$ % and 1.76: 1, respectively.

Table (2): Some biological parameters of *A. matricariae* reared on *B. schwartzi* under the lab. conditions of  $25 \pm 0.5$  °C,  $60 \pm 5$  % R.H. and photoperiod L: D 14:10 (N = 25).

Parameters	Mean $\pm$ SD
Egg-mummy period (days)	$6.44 \pm 0.50$
Mummy-adult period	$4.32 \pm 0.47$
Egg -adult period	$10.76 \pm 0.43$
Period to first mummies	$6.44 \pm 0.50$
Period to end mummies	$7.8 \pm 0.5$
Period to first adult	$10.76 \pm 0.43$
Period to end adult	$12.12 \pm 0.6$
Number of mummies/female	$13.04 \pm 5.01$
Number of adult/female	$11.96 \pm 4.55$
Percentage of emergence	$91.45 \pm 5.9$
Sex ratio (f :m)	1.76 : 1

Table (3): Mean numbers of mummies and adults emerged, % of emergence and sex ratio of *A. matricariae* on *B. schwartzi* under laboratory conditions (N = 20).

Females age (days)	Mean No. of		% Emergence	Mean No. of		Sex ratio (F:M)
	mummies	adults emerged		males	females	
1 <sup>st</sup>	10.25 ± 0.96 <sup>b</sup>	8.15 ± 1.30 <sup>b</sup>	75.17 ± 20.11 <sup>b</sup>	5.55 ± 1.14 <sup>a</sup>	2.6 ± 0.75 <sup>c</sup>	0.49 :1 <sup>b</sup>
2 <sup>nd</sup>	14.45 ± 0.60 <sup>a</sup>	13.2 ± 1.05 <sup>a</sup>	91.45 ± 7.49 <sup>a</sup>	5.15 ± 0.98 <sup>a</sup>	8.05 ± 1.19 <sup>a</sup>	1.65 :1 <sup>a</sup>
3 <sup>rd</sup>	9.5 ± 0.94 <sup>c</sup>	8.05 ± 0.88 <sup>b</sup>	84.84 ± 5.80 <sup>a</sup>	3 ± 0.72 <sup>b</sup>	5.05 ± 0.88 <sup>b</sup>	1.80 :1 <sup>a</sup>
4 <sup>th</sup>	4.45 ± 0.68 <sup>d</sup>	3 ± 0.64 <sup>c</sup>	67.83 ± 13.01 <sup>b</sup>	1.23 ± 0.43 <sup>c</sup>	2.35 ± 0.49 <sup>c</sup>	1.76 :1 <sup>a</sup>
LSD <sub>0.05</sub>	0.514	0.632	7.76	0.601	0.601	0.632

Statistical analysis showed significant differences among the parasitism rates in the four days. The mean number of mummies 14.45 ± 0.60 was highly significant in the 2<sup>nd</sup> day. Mean number of emerged adults 13.2 ± 1.05 was the highest and significant as well in the 2<sup>nd</sup> day. Also, emergence % 91.45 ± 7.49 and 84.84 ± 5.80 were highly significant in the 2<sup>nd</sup> and 3<sup>rd</sup> days, respectively.

It could be concluded from the obtained results that the 2<sup>nd</sup> day seemed to be the most proper day for parasitism.

These results are in harmony with the finding of Reed, *et al.* (1992), Bernal and Gonzolez (1993), Miller and Gerth (1994), Steenis (1995), Farias and Hopper (1999) and Agamy, *et al.* (2003).

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## الملخص العربي

### دراسة بيولوجيا مَنّ الخوخ (*Brachycaudus (Appelia) schwartzi* (Borner) وطفيله *Aphidius matricariae* (Hal.) (Hymenoptera: Aphidiidae)

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درست بيولوجيا حشرة مَنّ الخوخ (*Brachycaudus (Appelia) schwartzi* (Borner) وطفيله *Aphidius matricariae* (Hal.) (Hymenoptera: Aphidiidae) تحت الظروف المعملية. أظهرت النتائج وجود علاقة عكسية بين الحرارة ومدة الطور غير الكامل، طول حياة الحشرة الكاملة، الخصوبة، ومعدل موت مَنّ الخوخ، فعلى سبيل المثال انخفضت فترة طور الحورية من  $0.61 \pm 18.55$  يوماً على درجة حرارة  $15^\circ\text{C}$  إلى  $0.87 \pm 5.42$  يوماً على درجة  $30^\circ\text{C}$ ، وطول حياة الحشرة الكاملة من  $0.65 \pm 16.86$  يوماً على درجة  $15^\circ\text{C}$  إلى  $0.36 \pm 3.5$  يوماً على درجة  $30^\circ\text{C}$ ، وعلى نفس النمط كانت الخصوبة ومعدل الموت. أظهرت الدراسات البيولوجية على طفيل *A. matricariae* عند تطفله على مَنّ الخوخ أن فترات تطور المراحل: بيضة- مومياء، مومياء- حشرة كاملة، بيضة- حشرة كاملة قد بلغت  $0.5 \pm 6.44$ ،  $0.47 \pm 4.32$ ،  $0.43 \pm 10.76$  يوماً على درجة حرارة  $25 \pm 5^\circ\text{C}$ ،  $5 \pm 65\%$  رطوبة نسبية،  $10:14$  إضاءة: إظلام. أظهرت النتائج أيضاً وجود علاقة ارتباط معنوية بين طول حياة الحشرة الكاملة للطفيل والتغذية وبين الخصوبة وعمر الأنثى. أعطى التطفل في اليوم الثاني من عمر الأنثى أعلى متوسط معنوي لأعداد المومياءات ومعدلات خروج الحشرات الكاملة.