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Biological Characteristics of two Coccinellid Predators when Reared on *Aphis gossypii* Glover and an Artificial Diet under Laboratory Condition

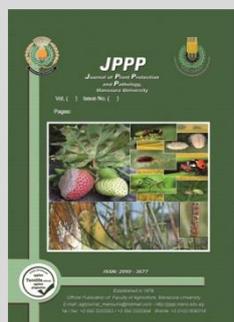
EL-Heneidy, A.H.¹; A. A. Ghanim^{2*}; Hala A. El-Serafy²; Nadia E. Mohamed¹ and E. H. E. Elbanna¹



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¹Plant Prot. Res. Institute, Agric. Res. Center, Giza Egypt.

²Econ. Entomol. Dept., Fac. of Agric., Mansoura Univ., Egypt.



ABSTRACT

Laboratory studies under constant temperature of $27 \pm 2^\circ\text{C}$ and 65 ± 5 RH were carried out in the insectary of Economic Entomology Department, Faculty of Agriculture, Mansoura University to develop an artificial diet for rearing two coccinellid predators species *Coccinella 9-punctata* L and *Chilomenus propinqua nilotica* (Mulsant). The results showed that the average duration of the predatory species, *C. 9-punctata* L. larval stage lasted 17.22 ± 1.75 days, when fed on the cotton aphid, *Aphis gossypii* Glover, and the average total larval consumption was 734.2 ± 10.65 . The pupal stage lasted 6.75 ± 0.85 days. The predator, s female consumed a total average of 2888.79 ± 67.54 and the number of deposited eggs per female averaged 1117.0 eggs. The predator male consumed a total average of 1765.23 ± 29.5 . Obtained data of *Ch. propinqua nilotica* larvae lasted 13.73 ± 1.12 days when fed on *A. gossypii*. Average total larval consumption reached 468.39 ± 21.6 . The predator, s female consumed a total average of 2022.45 ± 55.6 aphid individuals. The number of deposited eggs per predator female averaged $913. \pm 11.5$ eggs. The predator male consumed a total average of 1136.02 ± 38.4 . Obtained results of the two coccinellid predatory species when reared on an artificial diet, showed the average durations of larval stage lasted 22.15 ± 2.4 and 18.38 ± 1.96 days for *C. 9-punctata* and *propinqua nilotica*, respectively. Respective fecundity of the females of the two species was 360.62 ± 14.8 and 325.8 ± 11.5 eggs respectively. The results assured that the two predatory species reared successfully on this artificial diet.

Keywords: *Coccinella 9-punctata* L.; *Chilomenus propinqua nilotica* (Mulsant), *Aphis gossypii* Glover Artificial diets; Biology aspects.

INTRODUCTION

Nowadays the Multi-mate goal of any research program in pest control is reducing the pest status of insects through management of the populations. That can be achieved by introducing new tools to agriculture. One of the most promising-techniques is using of biological control agents the predatory insects may exceed the parasitoid in their efficiency, as they consume high number of the target pests during their life cycle, mostly are not specific on special species of their preys, and their role in the fields can be easily, recognize by the grow. El-Serafi *et al.*, 2002; El-Heneidy *et al.*, 2008. Therefore, two coccinellid efficient predatory insects were used in these experiments. However, to use these predators in the applied, it must be available at the time of needing with sufficient numbers. This can be achieved only by the mass-rearing of these insects artificially. The number of the insect predators that belonging to family Coccinellidae is about 4250 species (Klausnitzer and Klausnitzer 1986) and it is necessary to evaluate the predatory efficiency of the most dominant predators in Egypt.

Many investigators in different parts of the world studied the biological characteristics of certain Coccinellid predators when reared on natural preys and artificial diets (Ghanim and El-adl, 1997; Mohamed 2001; Bahy El-Din, 2014; Bayoumy *et al.*, 2015; Abdel-Salam, 2018; Shalaby, 2019 and Ghanim *et al.* 2021). There for, the current experiments were conducted to investigate certain biological

aspects of two coccinellid predators reared on *A. gossypii* and an artificial diet.

MATERIALS AND METHODS

1- Laboratory experiments

Laboratory studies under constant $27 \pm 2^\circ\text{C}$ and 65.7 ± 5 RH were carried out in the insectary of Economic Entomology Department, Faculty of Agriculture, Mansoura University develop an artificial diet rearing two coccinellid predators during the period from 2018 till 2019.

Table (A) shows one develop artificial diets have been prepared mixing holidic and meridic methods for rearing two predators namely: *Coccinella 9-punctata* L. and *Chilomenes propinqua nilotica* L. (Mulsant) The composition of this artificial diet was made according to the previous description of Ghanim and El-Adl (1997)

Table A. Composition of the artificial diets (AD) for rearing two coccinellid predatory insects.

No.	Ingredients	Amount %
1-	Dried yolk of eggs	5.47
2-	Dried fish	12.8
3-	Sucrose	55.5
4-	Pollen grains	5.6
5-	Yeast (Powdered)	3.96
6-	Royal Jelly (Capsule)	4.8
7-	Multivitamins and Mineral	5.19
8-	Antibiotic (Powdered)	1.67
9-	Dry powdered aphid	5.01

* Corresponding author.

E-mail address: ghanim@mans.edu.eg

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2- Biological characters of the two predaceous coccinellid insects reared on an artificial diet and natural prey.

Thirty replicates were prepared for each of the tested two predators. Each replicate was a Petri-dish of 10 cm in diameter, with filter paper in its bottom, containing one newly hatched larvae. About 250 mg of the tested diet was placed in the Petri-dish (9cm diameter), together with of a piece of cotton soaked with water for the larvae. The artificial diet and the cotton piece were changed weekly. The Petri-dishes were examined daily to observe the development of the immature stages and the periods of each stage were recorded. The same techniques on the two artificial diets were continued to produce ten couple adults for each predator. The longevity of males, females and female's fecundity were recorded. At the same time, the same biological characters were also secured for the two predators reared on the natural prey *A. gossypii* as a control. Forty newly hatched larvae from each of the five predators were introduced singly, into Petri-dishes (9 cm diameter). The bottom of each dish was covered with a filter paper to facilitate the predator larval movement. A known number from different stages of *A. gossypii* was introduced daily at 10 A.M. into each dish. A small plant leaflet was replaced daily in each Petri-dish as food for the aphids. The devoured aphid individuals were recorded daily. The mean number of predated aphids by each predator larval instars was calculated. From the emerged adults, ten sexed individuals of each predator were introduced singly into Petri dishes. The technique of rearing the adult stages was that the same of the larval stage, after copulation took place (after four days), the two sexes were separated and kept singly in the dishes. The total number of aphid's individuals consumed by a male or a female and the total number of eggs laid per each predator female were estimated.

RESULTS AND DISCUSSION

**1-Reared on *Aphis gossypii*
*Coccinella 9-punctata***

Data presented in Tables (1and 2) indicated that the average of the predator larval instars durated 17.22±1.75 days when fed on *A. gossypii*. The average of the total Consumption during the Four larval instars of this predator was 55.38±1.4; 60.36±1.49; 146.41±2.95 and 472.05±6.76 aphid individuals with a general average of 734.2±10.65 aphid individuals (Table 1). It can be noticed that the 3rd and 4th larval instars predation rates were 19.94% and 64.29% respectively from the total consumption of all larval instars. While that of the 1st and 2nd larval instars were 7.54% and 8.23% in sequence.

The average developmental time of pupal stage lasted 6.75±0.85 days. The predator female consumed a total average of 2888.79±67.54 aphid individuals with a daily rate of 47.83 aphid individuals per day during its longevity period which lasted 52.16±3.42 days (Table 2). A predator female devoured 1.63 times as that of male. The number of deposited eggs per predator female averaged 1117.0 eggs during the oviposition period reached an average of 37.85±1.35 days (Table 2). The adult female was consumed the most efficient predatory stage as is it consumed 3.93 time more than that of its larval stage as total preys. This is mainly adult the female need more energy to build up eggs in their ovaries and also the longest duration period of the female adult compared with of the larval stage. The obtained results presented in table 2 revealed that the predator male adult stage during its longevity period which lasted an average of 38.5±1.98 days consumed a total average of 1765.23±29.5 aphid individuals with a daily rate of 45.85 aphid individuals. These results generally agree with these of Hatting and Samways 1993; Imam, 2015 ; Said, 2018 ; Shalaby, 2019 and Ghanim et al. 2021.

Table 1. Duration of immature stages of *C. 9- punctata* and its feeding capacity when fed on *A. gossypii* under constant temperature of 27 °C±1 and R.H 70±5%.

A: Larval instars	Duration in days	Daily average consumption	Total consumption	% consumption
1 st instar	4.35±0.32	12.73	55.38±1.4	7.54
2 nd instar	2.75±0.29	21.95	60.36±1.49	8.23
3 rd instar	3.6±0.1-27	40.67	146.41±2.95	19.94
4 th instar	6.52±0.92	72.4	472.05±6.75	64.29
Total larval stage	17.22±1.75	36.94	734.2±10.65	100
Pupal stage	6.75±0.85	-	-	-

Table 2. Feeding capacity, longevity and fecundity of *C. 9- punctata* adults when fed on *A. gossypii* under constant temperature of 27 °C±1 and R.H 70±5%.

Adult Stages	Period in days	Daily average consumption	Total consumed	No. of eggs	
				Daily	Total
A: Female Pre-oviposition	4.56±0.4	42.9	195.62±4.75	-	-
Oviposition	37.85±1.35	60.94	2306.58±48.92	-	1117
Post- oviposition	9.75±0.8	39.65	386.59±8.56	-	-
Longevity	52.16±3.42	47.83	2888.79±67.54	-	-
B- Male Longevity	38.5±1.98	45.85	1765.23±29.5	-	-

Cheilomenes prpinqua nilotica

Tables (3and 4) showed that the results of certain biological characteristics of *C. prpinqua nilotica* when fed on *A.gossypii*. It can be seen from these (Table 3) that the average of the predator larval instars lasted 13.73±1.12 days on this aphid. The average of the total consumption during the four larval instars of the predator was 34.91±1.62; 49.87±2.53; 80.75±6.75 and 302.84±19.6 aphid individuals,

respectively, with a general average of 468.39±21.6 aphid individuals (Table 3). It can be noticed that the 3rd and 4th larval instar perdition rates were 17.24% and 64.65%, respectively from the total consumption of all larval instar. While that of the 1st and larval instars was 7.46% and 10.65% in sequence. The average development of pupal stage durated 5.3±0.8 days.

The predator female consumed a total average of 2022.45±55.6 aphid individuals with a daily rate of 38.3 aphid individuals during its longevity period which lasted 47.64±2.9 days (Table 4). A predator female devoured 1.80 times as that of the male. The number of deposited eggs per predator female averaged 913±11.5 eggs during the oviposition period which reached an average of 35.1±1.2 days. (Table 4). The adult female is considered the most effaced predatory stage as is it consumed 4.32 times more than that of its larval stage as total preys. This is mainly due to the female need more energy to build up eggs in their

ovaries and also the longes duration period of the female adult compared with that of the larvae.

From the results obtained in Table (4) indicated that the predator male adult stage during its longevity period which lasted an average of 31.75±1.3 days consumed a total average of 1136.02±38.4 aphid individuals with a daily rate of 35.78 aphid individuals.

These results generally agree with these of Belikova and Kosaev 1985; El-Hag and Zaitoon 1996; Mohamed, 1992; Sarhan *et al.* 2011 and Ghanim *et al.* 2021

Table 3. Duration of immature stages of *Cheilomenes prpinqua nilotica* and its feeding capacity when fed on *A.gossypii* under constant temperature of 27°C±1 and R.H 70±5%.

A: Larval instars	Duration in days	Daily average consumption	Total consumption	% consumption
1 st instar	3.9±0.2	8.95	34.91±1.62	7.46
2 nd instar	1.93±0.1	25.84	49.87±2.53	10.65
3 rd instar	2.62±0.15	30.82	80.75±6.75	17.24
4 th instar	5.65±0.42	53.6	302.84±19.6	64.65
Total larval stage	13.73±1.2	29.8	468.39±21.62	100
Pupal stage	5.3±0.8	-	-	-

Table 4. Feeding capacity, longevity and fecundity of *Cheilomenes prpinqua nilotica* adults when fed on *A. gossypii* under constant temperature of 27°C±1 and R.H 70±5%.

Adult Stages	Period in days	Daily average consumption	Total consumed	No. of eggs	
				Daily	Total
A: Female Pre-oviposition	4±0.25	38.54	154.16±2.72	-	-
Oviposition	35.1±1.2	45.78	1606.88±25.6	26	913±11.5
Post- oviposition	8.54±	30.61	261.41±7.65	-	-
Longevity	47.64±2.9	38.3	2022.45±55.6	-	-
B- Male Longevity	31.75±1.3	35.78	1136.02±38.4	-	-

2. Reared on an artificial diet.

Data obtained in Table (5) cleared that, duration periods of the two coccinellid predator *C. 9-punctata* and *C. propinque nilotica* when reared on an artificial diet: it can be seen from this table that, average periods of larval stage lasted 22.15±2.4 days and 18.83±1.96 days for *C. 9-punctata* and *C. propinque nilotica*, respectively. The pupal

stage durated in an average of 7.4±1.8 days and 6.85±1.45 days for *C. 9-punctata* and *Ch. propinque nilotica*, respectively. The results in this table revealed that, the mortality rates in immature stages of these predators reached 21.9% for *C. 9-punctata* and 19.5% for *Ch. propinque nilotica*.

Table 5. Duration period of two coccinellid predators larval instars, their pupal stage and percentage of mortality when reared on an artificial diet under constant temperature of 27 oC±1 and R.H 70±5%.

Immature stages	Duration of larval instars				Pupal stage	% Mortality
	1 st	2 nd	3 rd	4 th		
Predators					Larval stages	
<i>C. 9-punctata</i>	5.96±0.85	3.52±0.41	4.87±0.7	7.8±1.2	22.15±2.4	7.4±1.8
<i>Ch. prpinqua nilotica</i>	4.75±0.64	3.2±0.5	3.96±0.67	6.92±1.5	18.83±1.96	6.85±1.45

The obtained results in Table (6) indicated that, the average longevity and fecundity of *C. 9-punctata* female were 64.92±8.5 days and 360.62±14.8 eggs. While the average of male longevity was 45.9±4.23 days. The data in Table (6) cleared that the average longevity and fecundity of *Ch. propinque nilotica* female were 58.38±5.76 days and

325.80±11.50 eggs, respectively. While the average of male longevity was 40.52±2.7 days when this predator reared on an artificial diet. These results agree with these of Mohamed, 2001; El-Serafi *et al.* 2002; Bahy El-Din, 2014; Shalapy, 2019 and Ghanim *et al.* 2021.

Table 6. longevity and fecundity of two coccinellid predatory insects' adults reared on an artificial diet (AD) under constant temperature of 27 oC±1 and R.H 70±5%.

Adults	Female				(Male)
	Pre- ovipostion	Ovipostion	Post- ovipostion	longevity	longevity
Predators					
<i>C. 9-punctata</i>	7.47±1.2	44.8±3.6	12.65±0.85	64.92±8.5	45.9±4.23
<i>Ch. prpinqua nilotica</i>	6.75±0.92	40.88±3.5	10.75±0.5	58.38±5.76	40.52±2.7

Bahy El-Din (2014) recorded that the total larval period of *Coccinella undecimpunctata* L. lasted 15.97; 18.11; 12.85; 14.02; and 11.98 days on four artificial diets and reared this predator on *Aphis gossypii* under constant temperature of 27± 2 °C. He added that averages of mean number of deposited eggs by *C. undecimpunctata* were

204.15; 124; 518.35; 262.76 and 761.75 eggs female when the predator fed on the four artificial diets tested and *A. gossypii*. Shalaby (2019) found that on the artificial diets, as the temperature increased the developmental time from egg to adult of the eleven- spotted ladybird *C. undecimpunctata* was significantly prolonged.

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تقييم بعض الخصائص البيولوجية لمفترسين من فصيلة أبو العيد ربيت على من القطن و على بيئة صناعية تحت الظروف المعملية

أحمد حسين الهندي¹، عبد البديع عبد الحميد غانم²، هاله أحمد كامل الصيرفي²، نادية الحسيني محمد¹ و المرسي حمدي المرسي البنا¹
¹معهد بحوث وقاية النباتات- مركز البحوث الزراعية - الدقى - جيزة - مصر
²قسم الحشرات الاقتصادية- كلية الزراعة- جامعة المنصورة

أجريت تجارب معملية في معمل الحشرات بقسم الحشرات الاقتصادية - كلية الزراعة - جامعة المنصورة لتطوير بيئة صناعية لتربية نوعين من المفترسات الحشرية التابعة لفصيلة أبو العيد هما أبو العيد ذو التسع نقاط و أبو العيد السمنى و تقييم الخصائص البيولوجية لهذين المفترسين عند التربية عليها و على من القطن وأوضحت النتائج المتحصل عليها أن يرقة المفترس أبو العيد ذو التسعة نقط كان متوسط الفترة اللازمة لنموها ١٧,٢٢ يوم عند تربيتها على من القطن و كان متوسط ما استهلكته اليرقة من خلال فترة نموها ٧٣٤,٢ فردا من المن و لقد استغرقت فترة نمو طور العذراء ٦,٧٥ يوما بينما استهلكت انثى المفترس في تغذيتها ٢٨٨٢,٧٩ فردا من المن خلال فترة حياتها و وضعت انثى المفترس ١١١٧ بيضة خلال فترة وضع البيض عند التغذية على من القطن . أما الذكر فقد استهلك خلال فترة حياته ١٧٦٥,٢٣ فردا من المن كما أظهرت النتائج أن يرقة أبو العيد السمنى بلغت فترة حياتها ١٣,٧٣ يوم عند التغذية على من القطن و لقد استهلك اليرقة حوالي ٤٦٨,٣٩ فردا من المن أما أنثى المفترس فلقد استهلكت ٢٠٢٢,٤٥ فردا من المن و لقد وضعت انثى أبو العيد السمنى ٩١٣ بيضة عند التغذية على هذا المن أما الذكر فقد استهلك ١١٣٦,٠٢ فردا من المن طول فترة حياته و أوضحت النتائج نجاح تربية المفترسين أبو العيد تسعة نقط و أبو العيد السمنى على بيئة صناعية محضرة معمليا فقد استغرقت فترة الطور البرقى ٢٢,١٥ يوم فى حالة أبو العيد تسعة نقط و ١٨,٣٨ يوما فى حالة أبو العيد السمنى كما أظهرت النتائج أن انثى أبو العيد تسعة نقط وضعت ٣٦٥,٦٢ بيضة بينما انثى أبو العيد السمنى وضعت ٣٢٥,٨ بيضة عند التربية على هذه البيئة الصناعية المطورة و بذلك تؤكد النتائج نجاح تربية المفترسين أبو العيد تسعة نقط و أبو العيد السمنى على هذه البيئة