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### Biological Aspects of Two Coccinellid Predatory Insects Reared on Artificial Diets and Natural Preys under Constant Temperature

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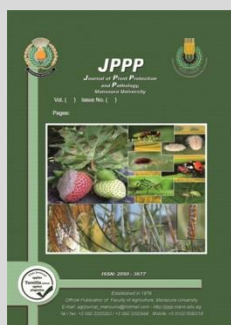
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#### ABSTRACT

Laboratory experiments were carried out in the Insectary of Economic Entomology Department, Faculty of Agriculture, Mansoura University to develop two artificial diets for rearing coccinellid predators during the period from 2017 till 2019. The results showed that the two predators reared successfully on these diets and the average period of larval instars lasted  $24.64 \pm 2.5$  and  $21.67 \pm 2.22$  days for *Hypodamia tridecimpunctata* L. and *Chilomenus propinqua isis* (Mulsant) when reared on the artificial diet (AD1), while that were recorded  $19.9 \pm 2.1$  and  $17.6 \pm 1.9$  days when these predators reared on the artificial diets AD2 respectively. The pupal stage was durated in average of  $6.24 \pm 0.48$  and  $5.42 \pm 0.42$  days when reared on the artificial diet (AD1) for these two coccinellid predators respectively. Meanwhile the data indicated that the pupal stage lasted in average of  $5.5 \pm 0.9$  days and  $4.95 \pm 0.97$  days when reared on the artificial diets AD2. The female average fecundity of *H. tridecimpunctata* and *C. propinqua isis* were  $150.7 \pm 8.1$  and  $193.4 \pm 10.5$  eggs when these predators reared on artificial diet (AD1). Meanwhile the obtained results showed that the average fecundity of *H. tridecimpunctata* and *C. propinqua isis* females recorded  $189.7 \pm 10.6$  and  $250.8 \pm 14.6$  eggs respectively when this predators reared on artificial diets (AD2). It can be concluded that the artificial diets (AD2) was very efficient for rearing *H. tridecimpunctata* and *C. propinqua isis* as the larval stage duration were two shorts on artificial diet (AD2) than artificial diet (AD1). The obtained data cleared that the females of each species deposited higher number of eggs on artificial diets (AD2).

**Keywords:** Artificial diets; Biology aspects; *Hypodamia tridecimpunctata* L.; *Chilomenus propinqua isis* (Mulsant).



#### INTRODUCTION

In recent years much interest has been given to biological control of harmful pests especially by predators and parasitoid insects. However, the success these biological control agents necessitate their presence in sufficient numbers when required. These obstacles can be only avoided by their rearing on artificial diets under controlled conditions (El-Bakoury, 1993).

People in Egypt are getting more conscious difficult by rearing coccinellid predatory insects on artificial diets more than on live preys. A major problem in the rearing of the coccinellid predatory insects' species is the diets formation Chandla *et al.* 2003, Buxton *et al.*, 2005.

The two approaches (holodic or meridic) are known for developing artificial diets for insects. The holodic diets are based on preparing a mixture of defined chemicals Okada, 1970; Chen and Qin, 1982. This has been achieved with only a few insects, as the demands of the insects on its hood are very complex and are not yet completely understood. Not only the diet must contain all necessary nutrients, but also the Good must have the current mechanical properties to facilitate its intake Hattingh and Samways 1993. The meridic diets based on preparing artificial duets by mixing different natural substances are such as honey, yeast, royal Jelly, which are rich in most of the necessary nutrients including carbohydrates, proteins

essential aminoacids, minerals, lipids and sterols. Numerous entomologists have made several attempts to rear predacious coccinellids.

Mass-rearing of predaceous coccinellids on natural preys is not easy, because the preys can be collected during a part of the season-together when obstacles facing the preys in both space and man power. Therefore attempts have been made to avoid these about the importance of using potatoes in their daily diet. Thus, demand of better quality is increasing. Potato plants in the field and potato tubers at storage should be protected against any pest infestation to reach the consumer in Egypt and abroad a healthy condition, Nakato *et al.* 2014 and Mesbah *et al.* 2016) on artificial diets prepared by using Holodic, or Meridic diets (; Abdel-Salam 1995, Ghanim *et al.* 2000 ; Mohamed 2001&Bahy El Din, 2014 ; said, 2018 and Shalaby 2019).

Many investigators in different parts of the world studied the biological aspects of some coccinellid predators when reared on artificial diets and natural preys (El-Serafi *et al.* 2002; Mohamed, 2013; Bayommy, *et al.* 2015 and Shalaby, 2019).

Therefore, the current experiments were conducted to investigate the effectiveness of two develop artificial diets on the biological aspects of two coccinellid predators inhabiting potato plants.

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## MATERIALS AND METHODS

### 1- Laboratory experiments

Laboratory studies under constant temperature of  $27 \pm 2^\circ\text{C}$  and  $65.7 \pm 5\%$  RH were carried out in the insectary of Economic Entomology Department, Faculty of Agriculture, Mansoura University develop two artificial diets rearing two coccinellid predators during the period from 2017 till 2018.

Table (1) shows two developed artificial diets have been prepared mixing holidic and meridic methods for rearing two predators namely: *Hippodamia tridecimpunctata* and *Chilomenes propinqua isis* L.

**Table 1. composition of the prepared artificial diets for rearing two predatory insect species**

No.	Ingredients	Amount %	
		AD1	AD2
1	Dried fish	10.5	11.9
2	Pollen grains	4.1	4.6
3	Dry powdered aphids	4.6	5.5
4	Yast (powdered)	3.5	2.9
5	Sucrose	61	57
6	Dried yolk of eggs	---	6.3
7	Dry powdered drone honey bee	4.5	---
8	Royal jelly (capsules)	4.2	3.7
9	Stereptophenicol	1.7	1.5
10	Multi-vitamins and minerals	5.9	6.1
Total		100	100

### 2- Biological characters of the predaceous coccinellid insects reared on the two artificial diets 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, together with 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

**Table 2. Durations of two predatory insects' larval instars, their pupal stage and percentage of mortality reared on artificial diet (AD1) under laboratory conditions of  $25^\circ\text{C} \pm 1^\circ\text{C}$  and R.H.  $70\% \pm 5\%$ .**

Immature stages Predatory insects	Durations of larval instars					Pupal stage	% of mortality
	1 <sup>st</sup> instar	2 <sup>nd</sup> instar	3 <sup>rd</sup> instar	4 <sup>th</sup> instar	Total in day		
<i>Hippodamia tridecimpunctata</i>	5.96±0.47	3.85±0.32	6.31±5.4	8.52±0.73	24.64±2.5	6.24±0.48	26.3
<i>Chilomenes propinqua isis</i>	4.86±0.39	3.46±0.27	5.83±0.51	7.52±0.62	21.67±02.22	5.42±0.42	24.5

**Table 3. Longevity and fecundity of the two coccinellid predatory insects' adults reared on the artificial diet (AD1) under constant temperature of  $25 \pm 1^\circ\text{C}$  and  $70 \pm 5\%$  R.H.**

Adults Coccinellid predators	Female			Male		
	Pre-ovi oviposition	Oviposition	Post oviposition	longevity	fecundity	Longevity
<i>Hippodamia tridecimpunctata</i>	16.2±0.98	58.50±4.79	20.2±3.5	94.9±8.7	150.7±8.10	77.60±6.4
<i>Chilomenes propinqua isis</i>	13.5±1.32	46.3±5.9	18.5±2.10	78.3±6.5	193.40±10.5	75.11±5.80

The data arranged in Table (4) revealed that the average period of larval stage lasted  $19.90 \pm 2.10$  and  $17.60 \pm 1.90$  days for *H. tridecimpunctata* and *C. propinqua isis* when reared on the artificial diet (2) respectively.

predators reared on the natural prey *Myzus persica* as a control. Forty newly hatched larvae from each of the five predators were introduced singly, into Petri-dishes of the same in 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 *M. persica* 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

### Biological characters of the two coccinellid predators reared on artificial diets and natural prey.

#### 1- Rearing on artificial diets

The data presented in Table (2) indicated that the average period of larval instars lasted  $24.64 \pm 2.5$  and  $21.67 \pm 2.22$  days for *H. tridecimpunctata* and *Chilomenes propinqua isis* when reared on artificial diets (table 2) respectively. The pupal stage lasted in average of  $6.24 \pm 0.48$  and  $5.42 \pm 0.42$  days for these two predators, respectively.

The mortality rates in immature stages reached in average 26.3% and 24.5% for *H. tridecimpunctata* and *C. propinqua isis*, respectively.

The female average longevity and fecundity of *H. tridecimpunctata* were  $94.90 \pm 8.7$  days and  $150.7 \pm 8.10$  eggs per female respectively (Table 3), while the average of male longevity recorded  $77.6 \pm 6.4$  days. The obtained results assured that the female average longevity and fecundity of *C. propinqua isis* were  $78.3 \pm 6.5$  days and  $193.40 \pm 10.5$  eggs per female respectively. The data showed that the average of male longevity lasted reared on the artificial diet (1).

The pupal stage durated in average of  $5.5 \pm 0.90$  days and  $4.95 \pm 0.79$  days for *H. tridecimpunctata* and *C. propinqua isis*, respectively. The mortality rates in

immature stages recorded in average 21.0% and 18.5% for these tested predatory insect species, Table (4).

The female average longevity and fecundity of *H. tridecimpunctata* were 89.9±7.5 days and 189.7±10.6 eggs per female respectively, Table (5). Meanwhile the average of male longevity reached 69.15±7.5 days per male. The results obtained cleared that the female average longevity and fecundity of the Coccinellid *C. propinqua isis* recorded 79.6±5.9 days 250±14.60 eggs per female respectively, when these insects reared on the artificial diet (D2). The

results revealed that the average of male longevity lasted 62.70±6.3 days per male (Table 5).

The data in Tables (5) revealed that the artificial diets (D2) was very efficient for rearing *H. tridecimpunctata* and *C. propinqua isis* as the female of each species deposited higher number of eggs on this diet compared with artificial diets number one (D1). These results agree with those of (Ghanim and El-Adl (1997) and Mohamed, 2001).

**Table 4. Durations of two predatory insects' larval instars, their pupal stage and percentage of mortality reared on artificial diet (AD2) under laboratory condition of 25°C±1°C and R.H. 70%±5%.**

Immature stages Predatory insects	Durations of larval instars					Pupal stage	% of mortality
	1 <sup>st</sup> instar	2 <sup>nd</sup> instar	3 <sup>rd</sup> instar	4 <sup>th</sup> instar	Total in day		
<i>Hippodamia tridecimpunctata</i>	5.10±0.50	3.15±0.20	5.25±0.60	6.4±0.80	19.90±2.10	5.5±0.90	21.0
<i>Chilomenes propinqua isis</i>	4.50±0.25	3.10±0.19	4.10±0.30	5.90±0.56	17.60±1.90	4.95±0.79	18.5

**Table 5. Longevity and fecundity of the two coccinellid predatory insects' adults reared on the artificial diet (AD2) under constant temperature of 25±1°C and 70±5% R.H.**

Adults Coccinellid predators	Female				Male	
	Pre-ovi oviposition	Oviposition	Post oviposition	Longevity	fecundity	longevity
<i>Hippodamia tridecimpunctata</i>	13.9±0.70	60.10±5.60	15.9±2.4	89.9±7.5	189.7±10.6	89.15±7.5
<i>Chilomenes propinqua isis</i>	11.50±0.61	48.5±4.50	19.6±3.1	79.6±5.9	250.80±14.60	82.70±6.3

Hong and Park (1996) in USA, reared the *Harmonia axyridis* on artificial diet (Chicken liver; sugar =5:2). The adult female laid an average of 163.9 eggs during its lifetime, longevity of female was 60.6 days. Ghanim and El-Adl (1996) and Imam, (2105) mentioned that artificial diet was a sufficient diet for rearing coccinellid predatory insects and there were significant differences between the artificial diet and natural prey (*A. gossypii*) on the immature stages duration , oviposition period and fecundity for three predatory insects. 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.

**2- Rearing the two coccinellid predators on natural prey *Myzus persicae*.**

Data presented in Table (6) indicated that the average duration period of larval instars lasted 11.87±1.6 days and 9.40±1.2 days for *H. tridecimpunctata* and *C. propinqua isis* when these predators reared on *M. persicae* respectively.

The pupal stage durated in average of 3.70± 0.85 and 3.10±0.60 days for these two coccinellid predators respectively. The mortality rates in immature stages reached in average of 10.5% and 9.5% of *H. tridecimpunctata* and *C. propinqua isis* respectively.

**Table 6. Durations of two Coccinellid predatory insects' larval instars, their pupal stage and percentage of mortality reared on *Myzus persica* under constant temperature of 25°C±1°C and R.H. 70%±5%.**

Immature stages Predatory insects	Durations of larval instars					Pupal stage	% of mortality
	1 <sup>st</sup> instar	2 <sup>nd</sup> instar	3 <sup>rd</sup> instar	4 <sup>th</sup> instar	Total in day		
<i>Hippodamia tridecimpunctata</i>	3.20±0.50	1.90±0.32	2.60±0.70	4.17±0.96	11.87±1.6	3.70±0.85	10.5
<i>Chilomenes propinqua isis</i>	2.80±0.3	1.50±0.20	1.70±0.62	3.4±0.79	9.40±1.2	3.10±0.60	9.5

The results in Table (7) showed that the female average longevity and fecundity of *H. tridecimpunctata* were 87.8±4.5 days and 610.4±15.6 eggs per female respectively (Table 7). Meanwhile the average of male longevity recorded 72.20±3.2 days. The results cleared that

the female average longevity and fecundity of *C. propinqua isis* were 79.70±3.10 days and 760.70±18.5 eggs per female, respectively. The data indicated that the average of male longevity lasted 65.10±2.8 days when these insects reared *M. persicae*.

**Table 7. Longevity and fecundity of the two coccinellid predatory insects' adults reared on *Myzus persica* under constant temperature of 25°C±1°C and R.H. 70%±5%.**

Adults Coccinellid predators	Female				Male	
	Pre-ovi oviposition	Oviposition	Post oviposition	longevity	fecundity	longevity
<i>Hippodamia tridecimpunctata</i>	6.4±0.75	70.9±2.5	10.5±0.61	87.8±4.5	610.4±15.6	72.20±3.2
<i>Chilomenes propinqua isis</i>	5.7±0.40	65.1±3.90	8.90±0.75	79.70±3.10	760.70±18.5	65.10±2.8

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**الخصائص البيولوجية لإثنين من المفترسات الحشرية لأبو العيد ربييت على بيئات صناعية تحت الظروف المعملية**  
**عبد البديع عبد الحميد غانم<sup>1</sup> ، هاله أحمد كامل الصيرفي<sup>1</sup> ، حورية عبد الوهاب حسن<sup>2</sup> ، نادية الحسيني محمد<sup>2</sup> و فاتن بهلول أبو المعاطي<sup>2</sup>**  
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أجريت تجارب معملية في معمل الحشرات بقسم الحشرات الاقتصادية كلية الزراعة جامعة المنصورة لتطوير بيئتين تم تحضيرهم صناعيا لتربية نوعين من المفترسات التابعة لفصيلة أبو العيد الفترة من 2017 و حتى 2019 و أظهرت النتائج المتحصل عليها أن المفترسين أبو العيد ثلاثة عشر نقطة و أبو العيد الأسود تم تربيتهم بنجاح على البيئتين و لقد بلغت فترة الاعمار اليرقية 24±2.5 يوما و أيضا 21.67±2.22يوما , بالنسبة لآبو العيد ثلاثة عشر نقطة و أبو العيد الأسود على التوالي عند التربية على البيئة الصناعية الأولى. أما بالنسبة لتربية هذين المفترسين على البيئة الثانية فكانت هذه الفترة هي 19.9±2.1 يوما , 17.6±1.9 يوما على التوالي. كما استغرقت فترة طور العذراء بالنسبة للنوع أبو العيد ثلاثة عشر نقطة 24±0.48 يوما و أما بالنسبة لآبو العيد الأسود فكانت 42±5.42 يوما عند التغذية على البيئة الأولى و لقد أوضحت النتائج أن مدة طور العذراء بالنسبة للمفترسين عند تربيتهم على البيئة الصناعية الثانية كانت كالآتي 5.5±0.9 يوما في حالة ابو العيد 13 نقطة بينما كانت 4.95±0.97 يوما عند تغذية هذين المفترسين على البيئة الصناعية الثانية , كما بينت النتائج أن انثى مفترس ابو العيد 13نقطة وضعت 150±8.3 بيضة لكل أنثى في المتوسط و بالنسبة لآبو العيد الأسود فكانت كفاءة الانثى التناسلية 193.4±10.5 بيضة لكل أنثى عند التغذية على البيئة الصناعية الأولى بينما وضعت الانثى 189.7±10.6 بيضة بالنسبة لآبو العيد 13 نقطة أما بالنسبة لآبو العيد الأسود فقط وضعت الانثى 250±14.6 بيضة لكل أنثى عند التغذية على البيئة الثانية من هذه الدراسة نستنتج أن مدة الاعمار اليرقية للمفترسين كانت أقصر عند التربية على البيئة الصناعية الثانية و وضعت الاناث عدد أكبر من البيض عند التربية على هذه البيئة .