



## Effect of Three Feeding Diets on Some Biological Aspects of The Black Earwig *Chelisoches morio* (Dermaptera:Chelisoichidae).

Ahmed A. Bardan<sup>1</sup>; Naglaa F. Abdel-Hameid<sup>2</sup>; Adel A. Hafez<sup>2</sup> and Fawzy F. Shalaby<sup>2</sup>

<sup>1</sup> Ph.D. Student, Plant Protection Dept., Faculty of Agriculture, Benha University

<sup>2</sup> Plant Protection Departments, Faculty of Agriculture, Benha University

### Abstract

Laboratory experiments were conducted to study the effect of three diets on some biological aspects when the black earwig, *Chelisoches morio* feeds on newly deposited eggs, and first larval instar of the cotton leaf worm, ground cat's dry food and newly deposited eggs of the red palm weevil. Results indicated that the eggs incubation periods of *Ch. morio* were 6.62, 7.33 and 9.00 days by rearing on the three diets, respectively. A single mated female deposited 95.62, 80.93 and 120.03 eggs per female by rearing on the three diets, respectively. The hatchability percentage among the deposited eggs reached 87.11, 88.22 and 86.11%, respectively. The longest duration was that of the 4<sup>th</sup> instars (24.7 days), when feeding took place on RPW eggs, while the shortest period was 7.2 days, for the first instar by feeding also on RPW egg. The sex-ratios of females (%) were 60, 56 and 64% females, respectively. The pre-oviposition period of the females was 30.69, 35.27 and 33.01 days, while the oviposition period was 67.54, 56.06 and 55.03 days, for the same treatment, respectively. The post-oviposition was 52.23, 31.00 and 46.00 days, respectively. Nymphs of the 4<sup>th</sup> instar fed on 329.8 eggs of RPW, being the highest voracious feeder as compared to the first three nymphal instars which consumed the means of 11.1, 65.9 and 166.0 individuals, respectively. The feeding capacity of adults was 1223.6 for males and 1357.4 for females indicating that females were more voracious than male. The study recommends feeding on RPW eggs in mass rearing of the black earwig for biological control.

**Keyword:** Earwig, *Chelisoches morio*, red palm weevil, feeding capacity, biology.

### Introduction

The black earwig, *Chelisoches morio* (Fabricius, 1775), is a predator commonly found in the crown of coconut palms infested with the red palm weevil *Rhynchophorus ferrugineus*. The biology of this forficulid was studied in the laboratory and field in Kerala State, India. (Abraham and Kurian, 1973).

A new earwig species of *Chelisoches Scudder*, 1876, *C. chongqingensis* Ye & Chen sp. nov. was reported in Chongqing City, China. The new species is characterized by the distinct metallic luster on the elytra and by the pygidium shape of the female. Descriptions and illustrations of both the males and females of the new species are provided. Another species, *Platylabia major* Dohrn, 1867, is redescribed based on material collected from Guangdong and Fujian provinces (Ye et al., 2020).

The black earwig is an indigenous 18mm-long predator insect (Brindle, 1975), common in the Mascarene (Zhong et al., 2016) also found in the Pacific Ocean (Ramage, 2017), known as a regulator of invasive coleopteran species (e.g., the coconut hispine beetle *Brontispa longissima* in Tahiti and

Red palm weevil *Rhynchophorus ferrugineus* in Reunion Island) (Dubos et al., 2020).

The black earwig is an important biological control agents and predaceous species and many of the earwigs, *Chelisoches morio* Fabr. (Dermaptera), is promising predator and plays a significant role in the agro-ecosystem Earwig is known as Cocopet (Indonesian name) which has many various colors. This black earwig has a structure-shaped like claws (pincers) on the last abdominal segment. The pincers are used to catch the prey and to protect themselves from predators. The pincers are also utilized to facilitate copulation. Cocopet is a typical polyphagous insect, killing many species and being used to control several insects such as mealybugs, coconut palm beetles, corn stem borer, sugarcane stem borer and red palm weevil (RPW) *Rhynchophorus ferrugineus*. (Rismansyah, 2014).

In present study, the effect of three feeding diets, newly deposited eggs and first instar larvae of the cotton leaf worm, ground cat's dry food and newly deposited eggs of red palm weevil was evaluated on different biological aspects of the earwig.

## Materials and Methods

### 1- Test insect

**1-1-** The black earwig adults, *Chelisoches morio* (Fabricius) (Dermaptera:Chelisochidae), were collected from palm trees infested by red palm weevil at Moshtohor and El-Deer (Qalyubia governorate), El-Qassasin (Ismailia governorate) districts in Egypt. Collected adults were reared in the laboratory on cotton leafworm eggs according to the method described by **Rejeki *et al.* (2020)**.

**1-2-** The red palm weevil, *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae), was reared according to the method described by **Abdel-Hameid (2019)**.

**1-3-** The cotton leafworm, *spodoptera littoralis*, (Boisd.) was reared on castorbean leaves as described by **Salama *et al.* (1971)**.

**1-4-** Tested diet: Ground cat's dry food was obtained from (Silver, Product from Economic, Egypt).

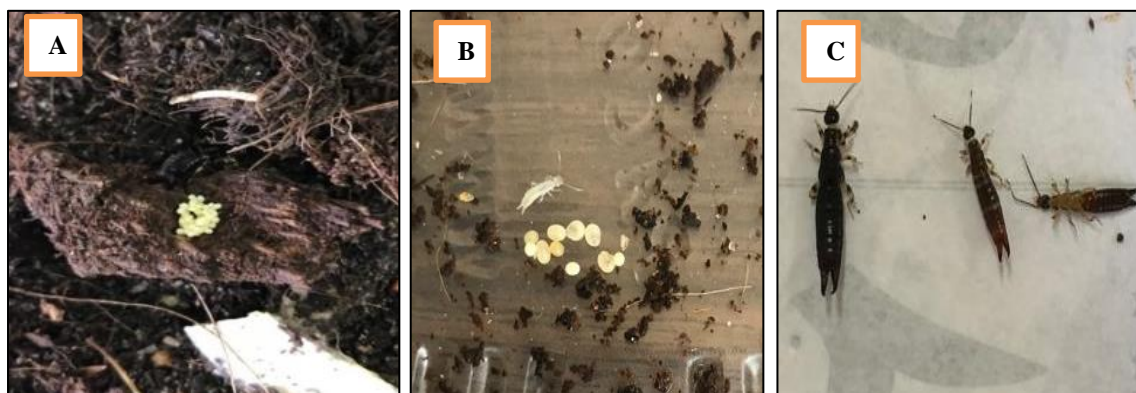
### 2-Effect of different diets on the biology of black earwig (*Chelisoches morio*) in laboratory

This experiment was conducted in 2021 at the Insect Research Laboratory at the Plant Protection Department, Faculty of Agriculture, Benha University, under laboratory conditions. At  $25\pm 2$  °C and  $65\pm 5\%$ R.H.

The experiment was designed according to a completely random design using 15 replicates of the three diet treatments tested.

Each diet was placed in a plastic can with an 8cm length, 8cm width, and 4cm height. The containers were filled with a mixture of soil and peatmoss in a ratio of 1:1. The diet was poured up to a high of 1-3 cm height then moistened using a water-filled hand sprayer. The plastic bottle's lid, with a height of 1-3 cm and a diameter of 3 cm, was used as a food plate. One pair (male and female) of black earwig was exposed to each container.

The duration of all tested stages of the earwig predator's life were studied from the development of the nymphal instars. The egg-laying periods, mean number of eggs laid per female, incubation period, egg-hatching percentage, and sex-ratio were recorded to investigate the effect of each of the tested diets on the insect's life-cycle (Plate, 1).



**Plate 1:** A: The group of the newly deposited eggs and the maternal brood's care for the eggs are illustrated by the constant presence of the female next to the eggs.

**B:** Newly hatched of eggs and the emergence of the first nymphal instar.

**C:** Second, third and fourth nymphal instar.

### 3-Estimation of feeding capacity *Ch. morio* on RPW eggs

In order to estimate the feeding capability of the different stages of *Ch. morio* to the prey, 20 individuals (10 of each sex) of newly hatched earwigs were placed for 2 minutes in the freezer to reduce their activity and define the sex through the shape of the tweezers on the last abdominal ring.

Each individual was placed in a plastic box (8 cm long, 8 cm wide, and 4 cm high) that contains a mixture (1:1) of soil and peat moss at a height of 1-3 cm. It was then moistened with water. Enough newly deposited RPW eggs were placed on the soil mixture's surface, as well as other diets.

The number of remaining RPW eggs was counted and replenished every day. The number of eggs consumed by one individual every day was

counted and recorded until the end of the life-cycle of the predator with adult mortality.

### 4-Statistical analysis:

Cumulative mortality at the end of the each experiment was analyzed by ANOVA (**Bakr, 2005**).

### Results and Discussion

#### 1- Effect of the tested diets on the biological aspects of the black earwig

##### 1-1- Egg-stage

The results presented in Table (1), show the number of egg clusters, total number of eggs, mean incubation period, percentage of hatching and sex-ratio among individuals produced by the black earwig couple fed on either of the three types of different foods. The type of food had a clear effect on the number of eggs clusters being 4.00, 3.40 and 5.70

cluster/female for the tested newly deposited of *S. littoralis* eggs, first larval instar of *S. littoralis* and ground cat's dry food and new eggs of red palm weevil, respectively. The total number of laid eggs by the black earwig female were 95.62, 80.93 and 120.03 eggs/female. This result indicating that the highest egg productivity occurred, significantly, after

feeding on the RPW eggs. Feeding on RPW eggs also the significantly indicated longest incubation period (9 day). The type food of *Ch. morio* did not affect the hatchability percentage (86.11 – 88.22 %). The resultant predator adults reared on RPW eggs recorded the highest percentage of females (64%) (Table, 1).

**Table 1.** Effect of three diets on eggs re-productivity of *Ch. morio* female.

Food	No. of eggs		Mean Inc. period/ days	Hatchability		Sex ratio (female %)
	Cluster	Total		Number	%	
Cotton leafworm	4.00 ± 0.44 <sup>a</sup>	95.62 ± 11.12 <sup>ab</sup>	6.62 ± 0.27 <sup>a</sup>	84.46 ± 10.52 <sup>a</sup>	87.11 ± 1.83 <sup>a</sup>	60%
Cats dry food	3.40 ± 0.29 <sup>a</sup>	80.93 ± 7.94 <sup>a</sup>	7.33 ± 0.29 <sup>b</sup>	71.93 ± 7.26 <sup>b</sup>	88.22 ± 0.98 <sup>a</sup>	56%
RPW eggs	5.70 ± 1.41 <sup>b</sup>	120.03 ± 5.00 <sup>b</sup>	9.00 ± 0.42 <sup>c</sup>	103.80 ± 4.93 <sup>a</sup>	86.11 ± 1.33 <sup>a</sup>	64%
<b>LSD at 0.05</b>	1.09	28.52	0.84	26.62	4.25	

a, b & c: There is nonsignificant difference ( $P>0.05$ ) between any two means, within the same column having the same superscript letter.

### 1-2- Nymphal duration:-

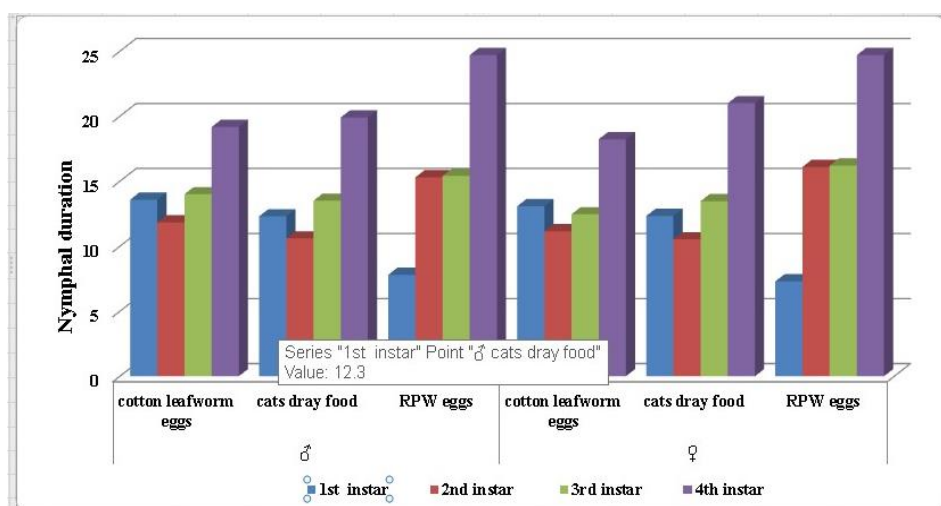
Results in Table (2) and illustrated in Fig. (2) indicated that the differences in nymphal duration between males and females during every nymphal instar were nonsignificant. While, significant differences were detected between nymphal instar by feeding on different diets (cotton leafworm eggs, cat's dry food and RPW eggs). By feeding on either of the first two diets, the 2<sup>nd</sup> nymphal instar manifested the shortest nymphal period (10.6 – 11.83 days) compared to rearing on RPW eggs (16.0 and 14.6 days) for males and females, respectively. On the other hand, nymphs of the 1<sup>st</sup> instar had the

shortest nymphal duration when fed on RPW eggs (7.2 and 7.4 days) respectively. Generally, the nymphal duration prolonged as the nymphal instar advanced being the longest (18.23 – 24.70 days) for the 4<sup>th</sup> nymphal instar (Table, 2 and Fig. 1). Comparing the effect of three diets on the total nymphal duration, Table (2) shows, clearly, that feeding on RPW eggs led to the longest total nymphal period (63.9 & 62.1 days for males and females, respectively, opposed to 58.58 & 54.92 days by feeding *S. littoralis* eggs, and 54.68 & 57.33 days by feeding on cats dry food).

**Table 2.** Developmental times of nymphal stages male and female of *Ch. morio* reared on three different diets.

Tested diet	Sex	Duration of nymphal stage/days				
		1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	Total
Cotton leafworm eggs	♂	13.58 ± 1.62 <sup>a</sup>	11.83 ± 1.9 <sup>a</sup>	14.00 ± 2.00 <sup>a</sup>	19.17 ± 3.19 <sup>a</sup>	58.58
	♀	13.08 ± 1.75 <sup>a</sup>	11.15 ± 1.86 <sup>a</sup>	12.46 ± 2.30 <sup>a</sup>	18.23 ± 2.49 <sup>a</sup>	54.92
Cats dry food	♂	12.03 ± 1.34 <sup>b</sup>	10.06 ± 2.37 <sup>b</sup>	13.50 ± 1.27 <sup>a</sup>	19.09 ± 1.45 <sup>a</sup>	54.68
	♀	12.33 ± 1.76 <sup>b</sup>	10.53 ± 1.55 <sup>b</sup>	13.47 ± 1.41 <sup>a</sup>	21.00 ± 1.51 <sup>a</sup>	57.33
RPW eggs	♂	7.2 ± 0.36 <sup>c</sup>	16 ± 0.47 <sup>c</sup>	16.1 ± 0.34 <sup>a</sup>	24.6 ± 0.90 <sup>c</sup>	63.9
	♀	7.4 ± 0.37 <sup>c</sup>	14.6 ± 0.62 <sup>c</sup>	15.4 ± 0.71 <sup>a</sup>	24.7 ± 0.80 <sup>c</sup>	62.1
<b>LSD at 0.05</b>		1.08	1.64	1.66	2.53	

a, b & c: There is nonsignificant difference ( $P>0.05$ ) between any two means, within the same column have the same superscript letter.



**Fig. 1.** Developmental times of nymphal stages males and females of black earwig *Ch. morio* reared on three different diets.

### 1-3- The adult's stage

From data presented in Table (3) and illustrated in Fig. (2), emergence of female adults emerged after rearing on dry food, adult female had, nonsignificantly, the longest preoviposition period (35.27 days, opposed to 30.69 and 33.01 for rearing on eggs of *S. littoralis* and RPW, respectively). The oviposition period was, significantly, the longest (67.54 days) by feeding on the cotton leafworm eggs, while nonsignificant difference occurred between rearing on the cats dry food and *R. ferrugineus* eggs (56.06 and 55.03 days, respectively). As for the postoviposition period, it was, significantly, longer by rearing on eggs of the cotton leafworm and the

red palm weevil (52.23 and 46.00 days, respectively), compared with the 31.00 days recorded by feeding on the cats dry food (Table, 3).

Concerning the longevity of male and female of adults, it is obvious from Table (3) and Fig. (2) that with either of the three feeding diets, females lived for longer period (122.33 – 150.46 days) than males (68.60 – 109.25 days). Also, the longest male and female longevities (109.25 and 150.46 days), respectively were detected by feeding on *S. littoralis* eggs, while, the shortest periods occurred when *Ch. morio* was reared on the cats dry food (68.60 and 122.33 days for male and female, respectively, Table, 3 and Fig. 2).

**Table 3.** Oviposition period and longevity of *Ch. morio* adults by rearing on three different diets.

Food	Sex	Ovipositional period/ days			Adults longevity / days
		PreOvi.	Ovi	PostOvi.	
Cotton leafworm	♂	-	-	-	109.25 ± 18.83 <sup>a</sup>
	♀	30.69 ± 1.88 <sup>a</sup>	67.54 ± 1.95 <sup>a</sup>	52.23 ± 2.18 <sup>a</sup>	150.46 ± 17.13 <sup>a</sup>
Cats dry food	♂	-	-	-	68.60 ± 4.81 <sup>b</sup>
	♀	35.27 ± 2.86 <sup>a</sup>	56.06 ± 3.32 <sup>b</sup>	31.00 ± 2.96 <sup>b</sup>	122.33 ± 18.73 <sup>b</sup>
RPW eggs	♂	-	-	-	105.04 ± 0.86 <sup>a</sup>
	♀	33.01 ± 0.34 <sup>a</sup>	55.03 ± 1.82 <sup>b</sup>	46.00 ± 1.41 <sup>a</sup>	134.04 ± 1.75 <sup>a</sup>
LSD at 0.05		7.54	8.54	8.05	13.58

a, b & c: There is non-significant difference ( $P > 0.05$ ) between any two means, within the same column having the same superscript letter.

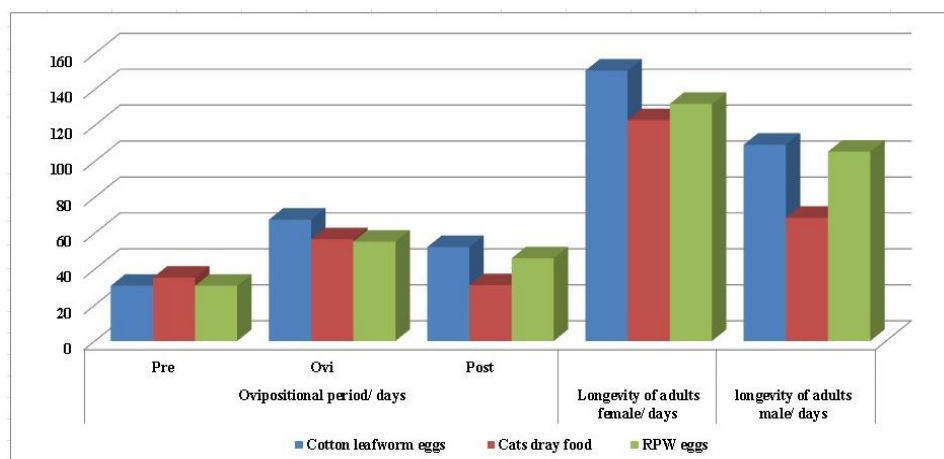


Fig. 2. Ovipositional periods and longevity of adults of *Ch. morio* black earwig were reared on three different diets.

Eggs were deposited in masses of 38-89 inside the pockets of the leaf axils with the average of 156 eggs per female. The incubation period for nymphal stage, adult stage and preoviposition, oviposition and post-oviposition periods lasted 6-7, 6-10, 7-11, 9-19, 13-22, 22-114, 20-24, 20-29 and 11-28 days, respectively. The ratio of males to females was 1:3 (Abraham and Kurian, 1973).

## 2- Feeding capacity of black earwig on red palm weevil eggs.

From the data presented in Table (4), it could be concluded that *Ch. morio* feeds successfully on eggs of the red palm weevil. The number of consumed eggs increased as the predator getting older. The highest daily consumption of eggs was 14.6 eggs/

day occurred by a fourth instar nymph, followed by 10.6 eggs / nymph/ day) for the third nymphal instar. While, on contrary, the lowest daily consumption of RPW eggs was recorded by the first instar nymph (1.6 eggs/day), opposed to 4.3 eggs by a nymph for the 2<sup>nd</sup> nymphal instar. In spite, of the lowest number of eggs devoured by one *Ch. morio* male or female adult were 9.5 and 10.1 eggs, respectively. The daily consumed diet by a one nymphal were 10.6 and 14.6 RPW eggs for the 3<sup>rd</sup> and 4<sup>th</sup> instar nymph, respectively. It was clearly observed that, the total consumed eggs devoured by one male or female were 1223.6 and 1357.4 eggs, respectively which is about 2.25 folds compared to those consumed throughout the whole duration of nymphal stage (Table, 4).

Table 4. Feeding capacity of *Ch. morio* against RPW eggs per day under laboratory condition ( $26 \pm 1^\circ\text{C}$  and  $65 \pm 5\%$  R.H.). (Data from 10 couples; 10 males and 10 females).

Nymphal instar & adult stage	Durations (days)	Consumed (eggs)	Mean daily Consumed
Nymphal instar	1 <sup>st</sup>	7.3	11.1
	2 <sup>nd</sup>	15.3	65.9
	3 <sup>rd</sup>	15.8	166.0
	4 <sup>th</sup>	24.7	329.8
Adult	Male	128.8	1223.6
	Female	134.4	1357.4

Durations of *Ch. morio* different stage varied with the type of food/diet on which it was reared. In this respect, Navasero M. M. and Navasero M. V., 2008 found that among the 3 diets tested, mealybug plus dog food was the best, producing the biggest adults that lived longer and laid the greatest number of eggs. (Dog food was later replaced with fish food). The first and second nymphal instar predators consumed the greatest number of first instar prey mealybug nymphs, followed by the second and third instars and the fewest consumed were adults. The third instar, fourth and adult male and female predators generally consumed the greatest number of prey mealybugs. This indicates that *C. morio* is a voracious predator.

Its big size and long adult life span make it a potential as biological control agent in the field.

The daily consumption by nymphs and adults, respectively, averaged 5.3 and 8.5 weevil eggs and 4.2 and 6.7 larvae (Abraham and Kurian, 1973).

## References

- Abdel-Hameid, N. F. (2019). Feeding of the red palm weevil, *Rynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae) larvae on natural and artificial diets in relation to biology and chemical contents. Egypt, Acad. J. Biolog. Sci., 12(2):43– 53.



- Abraham, V. A. and C. Kurian (1973).** *Chelisothes moris* F.(Forficulidae: Dermaptera), a predator on eggs and early instar grubs of the red palm weevil *Rhynchophorus ferrugineus* F.(Curculionidae: Coleoptera). Journal of Plantation Crops, 1: 147-152.
- Bakr, E.M. (2005).** A new software for measuring leaf area, and area damaged by *tetranychus urticae* Koch. J. Appl. Entomol. 129(3): 173-175.
- Dubos, N.; G. Deso and J. Probst (2020).** Nocturnal foraging activity of the gold dust day gecko *Phelsuma laticauda* in Reunion and Mayotte. Données Naturalistes Animalières - Volume 26: 27.
- Navasero, M. M. and M. V. Navasero (2008).** Development, prey consumption and mass production of *Chelisothes morio* F.(Chelisochoidea, Dermaptera). Philippine Entomologist, 22(2).
- Ramage, T. (2017).** Checklist of the terrestrial and freshwater arthropods of French Polynesia (Chelicerata; Myriapoda; Crustacea; Hexapoda). Zoosystema, 39 (2) : 213-225.
- Rejeki, A. S., M. Melina and A. Nurariaty (2020).** Rearing earwig *Chelisothes morio* (Fabricius) on a variety of artificial diets. In IOP Conference Series. Earth and Environmental Science (Vol. 486, No. 1). IOP Publishing.
- Rismansyah, E. A. (2014).** Uji daya predasi *Chelisothes morio* terhadap kumbang janur kelapa Brontispa Longissima di laboratorium. Balai Proteksi Tanaman Perkebunan Pontianak.
- Salama, H. S.; N. Z. Dimetry and S. A. Salem (1971).** On the host preference and biology of the cotton leaf worm *Spodoptera littoralis* Bois. Zeitschrift für Angewandte Entomologie, 67(1-4), 261-266.
- Ye, X. H.; J. Gu; M. Zhang and Z. T. Chen (2020).** Description of *Chelisothes chongqingensis* sp. nov.(Dermaptera: Chelisochoidea) and redescription of *Platylabia major* Dohrn, 1867 from China. Zootaxa, 4790(3), zootaxa-4790.
- Zhong, B; L. Chaojun and W. Qin (2016).** Preliminary Study on Biology and Feeding Capacity of *Chelisothes morio* (Fabricius) (Dermaptera: Chelisochoidea) on *Tirathaba rufivena* (Walker). Springer Plus 5:1944, 1-4. DOI 10.1186/s40064-016-3628-95.

#### تأثير التنوع الغذائي على دورة الحياة في تربية المفترس ابرة العجوز السوداء (*Chelisothes morio* (Dermaptera: Chelisochoidea))

أجريت تجارب معملية لدراسة بعض الجوانب البيولوجية عند تغذية المفترس ابرة العجوز السوداء على ثلاث انواع من البيئات هي البيض والعمر اليرقي الأول لدودة ورق القطن، غذاء القطط المجفف المطحون والبيض الموضوع حديثاً لسوسة النخيل الحمراء. وقد تم تقدير القدرة الإفتراضية للمفترس ابرة العجوز السوداء. أجريت جميع الدراسات تحت ظروف مختبرية عند درجة حرارة  $25 \pm 2$  درجة مئوية ورطوبة نسبية  $65 \pm 5\%$ . أشارت النتائج إلى أن فترة حضانة بيض المفترس 6.62 و 7.33 و 9.00 يوم بتربيتها على البيئات الثلاثة على التوالي. وضعت الأنثى عدد 80.93 و 95.62 و 120.03 بيضة/أنثى بتربيتها على البيئات الثلاثة على التوالي. بلغت نسبة قفس البيض الموضع 87.11، 88.22 و 86.11% على التوالي. من بين الأعمار الحورية الرابعة، كان العمر الحوري الرابع هو الأطول (24.7 يوماً)، عندما تمت تغذيته على بيض سوسة النخيل الحمراء، بينما سجل أقصر فترة 7.2 يوماً، في العمر الحوري الأول عن طريق التغذية على بيض سوسة النخيل الحمراء أيضاً. وكانت النسبة الجنسية (%) من الإناث، 60 و 56 و 64% إناث على التوالي). بلغت فترة ما قبل وضع البيض للإناث 30.69، 35.27 و 33.01 يوماً، في حين كانت فترة وضع البيض 67.54، 56.06 و 55.03 يوماً، ومدة ما بعد وضع البيض 52.23، 31.00 و 46.00 يوماً، على التوالي. افتتست الحوريات من العمر الرابع 329.8 بيضة من سوسة النخيل الحمراء، وهي أعلى قدرة افتراضية مقارنة بالأطوار الثلاثة الأولى التي استهلك 11.1 و 65.9 و 166.0 بيضة على التوالي. وكانت القدرة الافتراضية/بالغة 1223.6/ذكر و 1357.4/أنثى مما يدل على أن الأنثى أكثر شراً من الذكر.

الكلمات الدالة: *Chelisothes morio*, سوسة النخيل الحمراء, القدرة الإفتراضية, دورة الحياة.