BIOLOGICAL ASPECTS OF TWO PREDATORS AS AFFECTED BY FEEDING ON TWO APHID SPECIES, *APHIS GOSSYPII* GLOVER AND *HYALOPTERUS PRUNI* (GEOFFROY) UNDER LABORATORY CONDITIONS

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Abstract

Laboratory experiments were carried out to study certain biological parameters of the two predatory species *Coccinella undecimpunctata* L. and *Chrysoperla carnea* (Stephens) by rearing confinement on *Aphis gossypii* and *Hyalopterus pruni*. The total developmental time from egg hatching to adult eclosion were 18.85 ± 0.26 and 21.60 ± 0.2 days for *C. undecimpunctata,* while it was 26.16 ± 0.56 and 24.42 ± 0.29 days for *Ch. carnea* when fed on *A. gossypii* and *H. pruni,* respectively. Based on statistical analysis , the total developmental time showed significant difference between the two aphid species. The total consumption rate per *C. undecimpunctata* larva from the two aphid species were 190.05 ± 4.75 and 246.55 ± 7.26 aphids individuals and 172.45 ± 6.24 and 623.18 ± 41.80 Aphids individuals for *Ch. carnea.* When reared on *H. pruni* and *A. gossypii ,* respectively. The average number of aphids consumed per larva for the two predatory species was also significantly different. There were a significant difference in longevity among females, longevity of males and the fecundity of their females of the two predators. The average numbers consumed from the two aphid *A. gossypii* and *H. pruni* during adult female of *C. undecimpunctata* were 3046.4 ± 104.29 and 3797 ± 124.72 aphid individuals, while adult males consumed 2478.9 ± 66.19 and 2947.5 ± 95.08 aphid individuals when fed on the two aphid species respectively. The average number of deposited eggs per *C. undecimpunctata* female was 181.1 ± 5.97 and 301.9 ± 7.3 eggs when reared on *A. gossypii* and *H. pruni,* respectively, while that was 327.73 ± 31.19 and 459.43 ± 24.57 eggs when *Ch. carnea* females fed on *A. gossypii* and *Hyalopterus pruni* during larval instars, respectively. The statistical analysis showed that the aphid species have a highly significant effect on the female fecundity.

Key words: Biological characteristics, *Coccinella undecimpunctata* L. *Chrysoperla carnea,* Stephens *Aphis gossypii,* Glover *Hyalopterus pruni* (Geoffroy).

INTRODUCTION

Aphids are considered as one of the most important pests due to their vary wide range of host plants in Egypt and in many parts of the world (Megahed 2000). Use of insecticides in controlling aphids have lead to several problems, not only increasing resistant strain of aphids to those chemicals but also induction of environmental pollution and disturbance of natural balance (El-Maghraby, 1993). The efficiency of the two predators, *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae) and *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) as biological control agents have been studied in different parts of the world (Soares *et. al.,*2003 and Ali 2008). Several studies have been carried out in different parts of the world concerning the predation activity of many predator species such as, *C. undecimpunctata* and *Ch. carnea.* Among those who contributed much to these studies are (Abou Zeid *et. al.,*1978, Yuksel and Goemen 1992, Eraky and Nasser 1993 and El-Hag and Zaitoon 1996). The neuropteran predators *Chrysoperla carnea* and *Ch. septempunctata* Wesm. have attracted considerable attention as a biological agent to control important agricultural pests. *Ch. septempunctata* is one of the few species among the chrysopids which both its larvae and adults are predaceous (Abou-Bakr, 1989). Therefore, this investigation was out lined to study certain biological characteristics of the coccinellid predator, *C. undecimpunctata* and the neuropteran predator, *Ch. carnea* when reared on two aphid species *Aphis gossypii* Glover and *Hyalopterus pruni* (Geoffer) under laboratory conditions.

MATERIALS AND METHODS

Experiments were carried out at the laboratory of plant protection Sharkia branch under 27 $\pm$ 1°C and 70 $\pm$ 5.0% R.H. two aphid species, namely, *Aphis gossypii* and *Hyalopterus pruni* were used as preys for the two predators, *Coccinella undecimpunctata* and *Chrysoperla carnea.* The predators and the prey individuals were obtained from a maintained culture in the insectary also preys were collected directly from the field.

A. Larva experiments

Newly hatched predators larvae from two predators were put individually in a Petri – dish (10 cm. diameter) with a filter paper on its bottom. Twenty replicates from each were reared on two aphid species. Know surplus numbers of prey species were offered and the devoured individuals were replaced daily. Attacked prey

individuals were counted and recorded daily throughout the periods of the larval instars.

B. Adult experiments

1. *Coccinell undecimpunctata*

After emergence from the pupae, each predator adults were sexed and then introduced singly into a Petri- dish. Known numbers of the two aphids were offered daily on a plant leaflet to each predator. Counting and removing the un- devoured aphids in each Petri- dish were practiced before introducing the new aphid individuals. After five days of emergence, copulation took place and the two sexes were immediately separated and kept singly in the dishes. Daily numbers of laid eggs per predator female during its ovipositional period was counted. In addition, the total number of eggs laid per predator female was estimated. The daily averages of prey consumption throughout adult longevities were calculated.

2. *Chrysoperla carnea*

When larva was transferred to the pupal stage in the spherical silky cocoon, date of cocoons formation was recorded. The cocoons were left until adult emergence. Newly emerged adults were sexed and each pair (one male and one female) was placed in a glass chimney. Each chimney was placed on a half Petri dish (10 cm in diameter) and furnished with a moistened filter paper to provide humidity. A piece of cotton wool soaked with mixed solution of sugar and honey was placed inside the glass chimney as food for adults. Each chimney was covered with a piece of black cloth for encouraging females to oviposit. Pre oviposition, oviposition , post oviposition period, total number of eggs/female and longevity (female and male) were recorded.

C. Data analysis

Data for the developmental time of immature stages mortality, pre oviposition, oviposition, post oviposition periods, fecundity, male longevity, of the two predators reared on the tested aphid species were subjected for one way analysis of variance (ANOVA), and the means were separated using Dancan's Multiple Range Test (CoHort Software, 2004).

RESULTS AND DISCUSSION

1. Developmental time of immature stages

A. *Coccinella undecimpunctata*

Data in Table (1) indicated that the incubation period of *C. undecimpunctata* are 4.75 ± 0.12 and 4.25 ± 0.1 days with significant difference among the two aphid species (*A.gossypii* and *H. pruni*). Considering the developmental time of larvae instars, the shortest developmental time was obtained when larvae reared on *A. gossypii* (9.8 ± 0.2 days), while the longest time was recorded on *H. pruni* (11.15 ± 0.12 days). The developmental of larval instars showed a significant variation between the two aphid species (Table 1). From the tested aphid species, there were significant differences between developmental times of pupal stage. The longest time was observed with *H. pruni,* while the shortest time was obtained with *A. gossypii*. The total developmental time (from egg hatching to adult eclosion) ranged however, from 18.85 ± 0.26 days by rearing on *A. gossypii* to 21.60 ± 0.29 days by feeding on *H. pruni* with significantly differed. Mortality percentage from egg to adult ranged from 6.67% when reared on *H. pruni* to 10.0% with *A. gossypi.*

These findings agree with that of Abou Zeid *et. al.* (1978) reported that the incubation period of *C. undecimpunctata* was 2.7 days at 26-28°C. Eraky and Nasser (1993) mentioned that this period for the same predator was 2.0 days at 30°C. While El-Hag and Zaitoon (1996) found this period was 3.5 days at 25.0 ± 2.0°C Ghanim and El-Adl (1987) found that larvae of *C. undecimpunctata* and *C. vicina isis* took 10.0 and 9.0 days when reared on both aphids, *Rhopalosiphum maidis* (Fitch) and *S. avenae*. When *C. undecimpunctata* reared on *R. padi* L., the larvae , pupae and complete immature stages averaged 7.0, 2.5 and 12.0 days at 30°C (Eraky and Nasser 1993). On the other hand Mohammed (1996) found that when *C. undecimpunctata* reared on *Macrosiphum pisi* (Harris) the larvae , pupae averaged 9.2 and 2.9 days at 26°C. Mean while, Barakat (2005) reported that the incubation period, larva, pupa and total developmental period was lasted 5.7, 11.0, 7.6 and 24.3 days at 26.8°C when predator *C. undecimpunctata* reared on *H. pruni,* the fourth larval instar were consumed 15.7, 50.4, 48.2 and 157.9 individuals respectively.

B. *Chrysoperla carnea*

Data in Table (2) showed that incubation period of *Ch. carnea* was 3.75 ± 0.10 and 3.15 ± 0.08 days, when reared on *H. pruni* and *A. gossypii,* respectively. Considering the developmental time was obtained when larvae reared on *H. pruni* (13.31 ± 0.19 days), while the longest time was recorded on *A. gossypii* (16.38 ± 0.47 days). The developmental of larval instars showed a significant variation between the two aphid species (Table 2). From the tested aphid species, there was significant

differences between developmental times of pupal stage. The longest time was observed with *H. pruni,* while the shortest time was obtained with *A. gossypii.* The total of immature stages were ranged from 24.42 ± 0.29 days by rearing on *H. pruni* to 26.16 ± 0.56 days by feeding on *A. gossypii* with significantly differed. Mortality percentage from egg to adult ranged from 5.0% to 10% when reared on *H. pruni* and *A. gossypii*, respectively. These findings agree with that of Atlihan *et. al.* (2001) in Turkey who mentioned that the total developmental period of *C. carnea* was 18.81 days when larvae were fed on *H. pruni* at means of 25 ± 1°C and 65 ± 5% R.H. On the other hand, Balasubramani and Swamiappan (1994) found that the total developmental period of *C. carnea* was 20.15 days when the larvae were fed on *A. gossypii* infesting cotton. While, El-Maghraby *et. al.* (2008) found that the total developmental period of *C. carnea* was 19.38 ± 0.23 and 24.65 ± 0.49 days by rearing on *H. pruni* infested peach trees and *A. gossypii* infested navel orange trees, respectively. Under 28 – 29°C and 62 ± 5% R.H.

2. Feeding capacity

A. *Coccinella undecimpunctata*

Data in Table (3) show the consumption period rate of *C.undecimpunctata* larval instars when reared on two aphid species. The average number of aphids consumed during the larva stage was 190.05 ± 4.75 individuals of *H. pruni* and 246.55 ± 7.26 individuals of *A. gossypii.* The average number of aphids consumed during fourth instar larvae were 103.55 ± 3.77 individuals of *H. pruni* and 125.25 ± 5.17 individuals of *A. gossypii*. Consumed percentage differed between 50.80 % on *A. gossypii* to 54.49% on *H. pruni*. The average number of consumed aphid per larvae was significantly different. On other hand Mohammed (1996) found that the average of the total consumption during the four larval stages of the predator *C. undecimpunctata* when reared on *M. pisi* was 27.7, 68.4, 123.9 and 144.0 individuals, respectively. While, Barakat (2005) mentioned that the average of the total consumption during four larval stages of the same predator was 15.7, 50.4, 48.2 and 157.9 individuals, respectively when feeding on *H. pruni.*

B. *Chrysoperla carnea*

Data in Table (4) show the consumption period rate of *Ch. carnea* larval instars when reared on two aphid species. The average number of aphids consumed during the larval stage was 172.45 ± 6.24 individuals of *H. pruni* and 623.18 ± 41.8 individuals of *A. gossypii* . Consumed percentage differed between two aphid species, the third instar larvae was consumed a high percentage 46.26% of *H. pruni* and 59.13% of *A. gossypii* followed by second instar larvae 31.77% and 27.23% then the first instar larvae 21.97% and 13.64% of *A. gossypii* and *H. pruni,* respectively. These findings agree with that of Yuksel and Goemen 1992 in Turkey determined prey consumption of *C. carnea* in the laboratory at 25 and 30°C using *A. gossypii* 1st larval

instar predated on 53.6 and 60.3 individuals at 25 and 30°C, respectively, 2nd larval instar consumed 174.4 and 88.6 aphid and 3rd larval instar fed on 724.4 and 506.7 preys respectively. On the other hand El-Maghraby *et. al.* 2008 found that the total larval stage of *C. carnea* consumed 169.53 ± 6.45 individuals of *H. pruni* and 617.57 ± 5.29 individuals of *A. gossypii* infested navel orange, under 28- 29°C and 62 ± 5% R.H.

3. Longevity and fecundity of adult stage

A. *C. undecimpunctata*

Data in Table (5) and Figure (1) showed that the mean female longevity of this predator was significantly longer when fed on *H. pruni,* than when reared on *A. gossypii.* Also the mean male longevity of predator was significantly longer when fed on *H. pruni* and shortest on *A. gossypii*. The highest numbers of egg (301.9 eggs) were obtained when female fed on *H. pruni* followed by *A. gossypii* (181.1 eggs). The predator male adult consumed a total average 2478.9 when fed on *A. gossypii* and 2947.5 when reared on *H. pruni,* mean while the female consumed a total average of 3046.4 *A. gossypii* individuals, but it consumed a total average of 3797 *H. pruni* individuals Fig. (1). Eraky and Nasser (1993) noted that egg production per female of *C. undecimpunctata* was 142.33 at 26°C. Whereas El-Hag and Zaitoon (1996) mentioned that oviposition and longevity periods for *C. undecimpunctata* females were 29.8 and 70.0 days. They found that number of eggs laid per female and daily mean of eggs were 370.5 and 142 eggs when reared on *B. brassicae* and *R. padi,* while Mohammed (1996) reported that oviposition and longevity period for the same predator females was 56.6 days with (481 eggs). The female consumed an average 4599.2 *M. pisi* individuals, during this period. On the other hand, Barakat (2005) found that oviposition and longevity period for this predator females was 43.5 days with (343.5 eggs) during this period. The female consumed an average 2531.7 *H. pruni* individuals while male consumed in average 2017.6 *H. pruni* individuals.

B. *Chrysoperla carnea*

Data in Table (6) showed that the mean female longevity of *C. carnea* was significantly longer when larvae fed on *H. Pruni* (46.96 days) than when reared on *A. gossypii* (39.28 days). Also the mean male longevity of predator was in significantly longer when fed on *A. gossypii* (10.14 days) than when reared on *H. pruni* (9.75 days). The highest numbers of egg (459.43 eggs) were obtained when larva fed on *H. pruni* followed by *A. gossypii* (327.73 eggs).

Table 1. Mean duration of the developmental stages of predator C. undecimpuncatata reared on two aphid species under controlled conditions.

Prey species	Incubation period	Larval instars					Pupal stage	Total of immature stages	Mortality %
		1st	2nd	3rd	4th	Total			
Aphis gossypii	3.70±0.11a	1.9±0.07b	2.15±0.1b	2.45±0.11a	3.3±0.12b	9.8±0.2b	5.35±0.11b	18.85±0.26b	10.0
Hyalopterus pruni	3.40±0.1a	2.2±0.09a	2.45±0.11a	2.7±0.12a	3.8±0.1a	11.15±0.21a	7.05±0.12a	21.60±0.29a	6.67

Mean followed by the same letter in a column for each predator are not significantly different at the 1% level of probability (Duncan's Multiple Rang Test).

Table 2. Duration (in days) (means + SD) of the developmental stages of Chrysoperla carnea (Stephens) reared on certain aphid species under controlled conditions.

Prey species	Incubation period	Larval instars				Pupal stage	Total of immature stages	Mortality %
		1st	2nd	3rd	Total			
Aphis gossypii	3.15±0.08b	4.5±0.13a	4.79±0.14a	7.0±0.34a	16.38±0.47a	6.61±0.26b	26.16±0.56a	10%
Hyalopterus pruni	3.75±0.10a	4.79±0.14a	4.26±0.10b	4.26±0.10b	13.31±0.19b	7.31±0.15a	24.42±0.29b	5%

Mean followed by the same letter in a column for each predator are not significantly different at the 1% level of probability (Duncan's Multiple Rang Test).

Table 3. Mean numbers consumed (+SE) and percentage from different aphid species during larval instars of predator C. undecimpunctata under controlled conditions.

Prey species	Larval instars								Total
	1st		2nd		3rd		4th		
	No.	%	No.	%	No.	%	No.	%	
H. prunii	11.05±0.49b	5.81	20.5±1.06b	10.79	54.95±2.31b	28.91	103.55±3.77b	54.49	190.05±4.75b
A. gossypii	14.20±0.77a	5.76	38.75±2.49a	15.72	68.35±1.63a	27.72	125.25±5.17a	50.80	246.55±7.26a

Mean followed by the same letter in a column for each predator are not significantly different at the 1% level of probability (Duncan's Multiple Rang Test).

Table 4. Mean numbers consumed (+SD) and percentage from different aphid species during larval instars of Chrysoperla carnea (Stephens) under controlled conditions.

Prey species	Larval instars						Total Mean ± SD
	1st		2nd		3rd		
	Mean ± SD	%	Mean ± SD	%	Mean ± SD	%	
Hyalopterus pruni	37.89±1.95b	21.97	54.78±3.19b	31.77	79.78±3.68b	46.26	172.45±6.24b
Aphis gossypii	85.0±3.83a	13.64	169.68±4.95a	27.23	368.5±37.56a	59.13	623.18±41.80a

Mean followed by the same letter in a column for each predator are not significantly different at the 1% level of probability (Duncan's Multiple Rang Test).

Table 5. Longevity (in days) and fecundity of predator C. undecimpunctata reared on two aphid species under controlled conditions.

Aphid species	Female longevity				Male longevity	Female fecundity	
	Pre-oviposition	Oviposition	Post-oviposition	Total		Daily	Total
A. gossypii	5.3±0.15b	33.7±1.18b	3.5±0.48b	42.5±1.0b	36.4±1.1b	4.77b	181.1±5.97b
H. pruni	6.1±0.23a	38.0±1.1a	4.3±0.39a	48.5±0.79a	39.0±1.0a	8.96a	301.9±7.3a

Mean followed by the same letter in a column for each predator are not significantly different at the 1% level of probability (Duncan's Multiple Rang Test).

Table 6. Longevity (in days) and fecundity of predator Chrysoperla carnea adults when reared on different types of food under laboratory conditions (27°C & 65 + 5% R.H.).

Aphid species	Female longevity				Male longevity	Female fecundity	
	Pre-oviposition	Oviposition	Post-oviposition	Total		Daily	Total
A. gossypii	5.0±0.73b	29.0±1.31b	5.28±0.36a	39.28b	10.14±0.73a	9.78b	327.73±31.19b
H. pruni	7.71±0.52a	33.5±1.55a	5.75±0.25a	46.96a	9.75±0.35a	15.84a	459.43±24.57a

Mean followed by the same letter in a column for each predator are not significantly different at the 1% level of probability (Duncan's Multiple Rang Test).

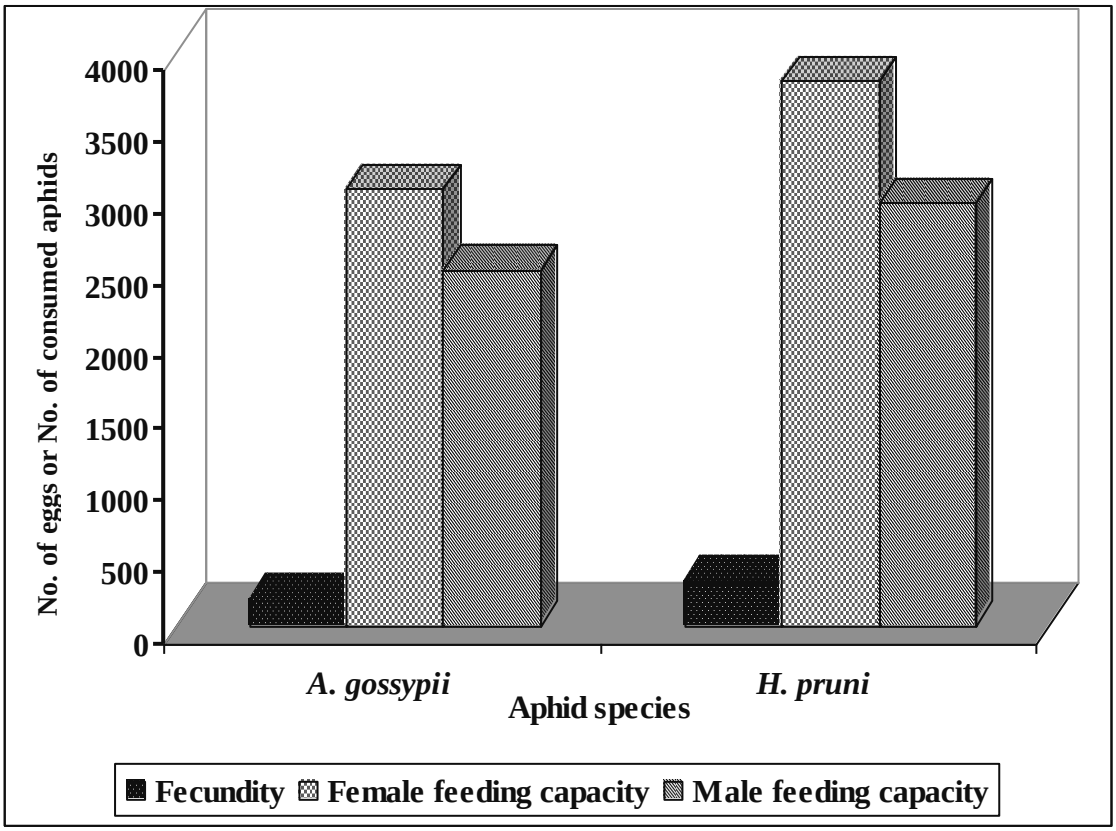

Fig. 1. Feeding capacity and fecundity of *C. undecimpunctata* adults reared on two aphid species under controlled conditions.

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الخصائص البيولوجية لمفترسين على من القطن ***Aphis gossypii*** **(Glover) ومن البرقوق الدقيقى ***Hyalopterus pruni*** (Geoffroy) تحت الظروف المعملية**

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2. *قسم بحوث الحشرات الثاقبة الماصة – معهد بحوث وقاية النباتات – مركز البحوث الزراعية الدقى – الجيزة – مصر*

أجريت دراسات معملية لدراسة بعض الخصائص البيولوجية لنوعين من المفترسات هما أبوالعيد ذو الأحدى عشر نقطة .L *Coccinella undecimpunctata* واسد المن *Chrysoperla carnea* (Stephens) عند تربيتهما على من القطن *A. gossypii* ومن البرقوق الدقيقى *H. pruni* تحت درجة حرارة ثابته 0

أوضحت النتائج أن فترة النمو من فقس البيض حتى خروج الحشرة الكاملة لمفترس أبو العيد ذو الأحد عشر نقطة كانت 18.85 ± 0.26 ، 21.60 ± 0.2 يوما بينما كانت 26.16 ± 0.56 ، 24.42 ± 0.29 يوما لمفترس أسد المن عند تربيتهم على من القطن ومن البرقوق الدقيقى على التوالى ولقد أوضحت نتائج التحليل الاحصائى وجود أختلاف معنوى بين مجموع فترات النمو لكل مفترس عند تربيته على نوعى المن0 وبلغ معدل التغذية الكلى ليرقة أبو العيد ذو الأحدى عشر نقطة 190.05 ± 4.75، 216.55 ± 7.26 فرداً من المن ويرقة أسد المن 623.18 ± 41.80 ، 172.45 ± 6.24 فرداً من المن عند التربية على من القطن ومن البرقوق الدقيقى على التوالى 0 وكان هناك اختلاف معنوى بين ماتستهلكة يرقة المفترس الواحد من نوعى المن المختلفين ، ووجد أن هناك اختلاف معنوى بين فترت حياة الحشرة الكاملة لأنثى كل مفترس وكفائتها التناسلية وفترة حياة الذكر باختلاف نوع الغذاء0وكان متوسط ماتستهلكة أنثى أبو العيد ذو الاحدى عشر نقطة من حشرة من القطن ومن البرقوق الدقيقى 3046.4 ، 3797 فرد على التوالى بينما استهلاك الذكر 2478.9 ، 2947.5 فرد من على التوالى 0 وكان متوسط عدد البيض الذى تتضعة أنثى أبو العيد ذو الأحدى عشر نقطة 181.1 ، 301.9 بيض عند تغذيتها على من القطن ومن البرقوق الدقيقى على التوالى 0 بينما وضعت أنثى اسد المن 327.73 ± 31.19 ، 459.43 ± 24.57 بيض عند تغذيتها فى طور اليرقة على من القطن ، ومن البرقوق الدقيقى على التوالى 0 وأضح التحليل الاحصائى أن هناك تأثير معنوى واضح لنوع الغذاء على الكفاءة التناسلية للأنثى وأشارت نتائج الدراسة أن كلا من مفترسى أبو العيد ذوالأحدى عشر نقطة وأسد المن يمكن أستخدامهما كعنصر من عناصر المكافحة الحيوية لمكافحة أنواع المن سابقة الذكر0