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INCREASING THE POTENTIALITY OF THREE PREDACIOUS INSECTS, BY STARVATION

El-Batran,Laila A.
Economic Entomology Dept., Faculty of Agric. Mansoura University

ABSTRACT

Efficiency of the three larval predacious insects, *Coccinella undecimpunctata* L., *Chilocorus bipustulatus* L., and *Chrysoperla carnea* Steph. larvae along with adults of the two former coccinellid beetles were estimated after varied periods of starvation (2, 4, 6, 8, 10, 24, and 26 hours). Starved individuals were reared on *Aphis gossypii* Glover under laboratory conditions. Results showed that starved larvae as well as adults of coccinellids were more positively to the preys as compared to those without starvation.

The successive four larval instars of *C. undecimpunctata* showed a maximum response after 4h., 8h., 10h., and 26h. of starvation, since the average numbers of consumed aphids / larvae were 26.8, 60.4, 99.2, and 108.6 respectively for its successive four larval instars. In case of *Ch. bipustulatus*, the same periods of starvation (4h., 6h., 10h., and 26h.) gave the maximum response, since the average numbers of consumed aphids / larvae were 24.4, 56.2, 90.4, and 102.4, respectively. For the successive four larval instars.

Results also concerning the average number of consumed aphids for adults of both sexes of coccinellid predators; after varied periods of starvation, since the maximum response was detected after 26 h. of starvation for adults of both coccinellids. The consumption of adults were 35.2, 55.2 aphids and 31.2, 48.4 aphids for male and female of *C. undecimpunctata* and Ch. *bipustulatus*, respectively. These results showed also that the rate of predation by *C. undecimpunctata* was much higher than that of *Ch. bipustulatus* in larval stage as well as in adults for almost all the same starvation periods.

In case of *C. carnea*, the average numbers of consumed aphids at the starvation periods 6, 8, and 10h, were 18.4, 47.8 and 99.2 / larvae for its three successive larval instars.

INTRODUCTION

Ladybirds (Coccinellids) have been recorded as predators for many different species of aphids (Mills, 1981). Lei *et al.* (1987) recorded the Coccinellid-effects on various densities of *Aphis gossypii* Glover as well as the rate of predation. El-Batran (1991) found that *Exochomus flavipes* (Thnb.) was very important to regulate the population density of *A. gossypii*. Bhagat and Masoodi (1986) mentioned, during their field observations in Kashmir and India, that larvae of *Chrysopa orestes* Banks fed on *A. gossypii*. El-Batran and Fathy (1991) studied the predacious efficiency of the *Chrysoperla carnea* Steph. larvae when fed on *Toxoptera aurantii* Boyer and *Coccus hesperidum* L. under laboratory conditions Zou-Yunding *et al.* (1997) found that the searching behavior of *Harmonia axyridis* (Pallas) larvae is influenced by many factors besides the degree of starvation. Ferran and Dixon (1993) reported that the amount of success of ladybird larval predation depends on many factors (age and level of hunger). Sengonca *et al.* (1995) studied the

olfactory reactions of *Cryptolaemus montrouzieri* Mulsant (Coccinellide) and *Chry. carnea* (Chrysopidae) in relation to period of starvation in a laboratory. Shukla *et al.* (1990) recorded that *C. septempuctata* larvae starved for 24 h. were more voracious than those had not been starved.

The aim of this study is to show the effect of starvation on increasing the potentiality of larvae of three predators; *Coccinella undecimpunctata*, *Chilocorus bipustulatus* and *Chrysoperla carnea* as well as the adults (male and female) of the former two predators.

MATERIALS AND METHODS

This study was carried out under the laboratory conditions of (30 ± 5 °C and 70 ± 5 % R.H.) during summer of 2000.

Adults of *Coccinella undecimpunctata L, Chilocorus bipustulatus* L and *Chrysoperla carnea* adults were collected from Mansoura University Farm at the summer season of 2000. The cotton aphid, *Aphis gossypii*, was collected from its host plants from the same farm to be used as food (prey) for the above-mentioned experimental predators. Five newly-hatched larvae from each of these predator were kept, individually, in Petri-dishes (10 cm. in diameter) at varying levels of starvation.(2, 4, 6, 8, 10, 24 and 26 hours) during the whole period of the larval stage to determine the consumption - rates of the prey (*A. gossypii*), for each level of starvation.

A known number, more than the requirements of each stage of *A. gossypii* was presented to every larval instar as well as adults (male and female), of *C. undecimpunctata* and *Ch. bipustulatus*, in addition to the three larval instars of *C. carnea*.

Number of consumed aphids, in each case, was calculated after 24 hours in each level of starvation.

Statistical analysis was made by using analysis of variance and comparisons between means were adopted by calculating the least significant difference (L.S.D.).

RESULTS AND DISCUSSION

A: Predacious efficiency of larvae

Table (1) and Fig. (1) show the average number of the consumed prey, *A. gossypii*, by different stages of larvae of *C. undecimpuctata*, *Ch. bipustulatus* and *C. carnea* fed after different periods of starvation.

Results, in general, showed a retard relationship between the consumed numbers of aphids and the period of starvation. It also showed that the average number of consumed aphids increase as the larvae progressed in age from one instar to the other.

Results in Table (2) showed the variance ratio between starvation periods and between the larval instars of the three predators along with the corresponding L.S.D.

Table (1): **Average no. of consumed aphids (per larvae or adult) by different larval instars of the three predator insects, as well as the two coccinellids' adults after seven periods of starvation**

			Starvation period (hrs)							
			2	*4*	*6*	*8*	*10*	*24*	*26*	***Mean***
C. undecimpunctata	*Larval stage*	1st	16.2	26.8	17.4	20.2	22.6	23.2	25.2	***21.6***
		2nd	44.8	50.4	52.4	60.4	53.2	56.6	57.4	***53.6***
		3rd	52.2	62.8	80.4	85.2	99.2	86.4	92.6	***79.8***
		4th	70.4	80.2	85.4	90.2	92.6	95.4	108.6	***89.0***
		Mean	***45.9***	***55.05***	***58.9***	***64.0***	***66.9***	***65.4***	***70.95***	
	Adult stage	Male	18.2	19.2	20.4	26.2	28.2	29.2	35.2	***25.23***
		Female	30.2	35.4	40.6	45.3	47.2	50.2	55.2	***43.44***
		Mean	***24.2***	***27.3***	***30.5***	***35.75***	***37.7***	***39.7***	***45.2***	
Ch. bipustulatus	*Larval stage*	1st	15.2	24.4	16.4	18.8	19.2	21.8	22.2	***19.71***
		2nd	40.6	48.4	56.2	45.4	49.2	53.4	42.2	***47.91***
		3rd	50.8	63.4	75.2	78.6	90.4	84.2	80.4	***74.71***
		4th	68.8	77.4	80.6	85.4	88.2	93.2	102.4	***85.14***
		Mean	***43.85***	***53.4***	***57.1***	***57.01***	***61.75***	***63.15***	***61.8***	
	Adult stage	Male	15.2	16.4	18.3	24.2	24.9	26.2	31.2	***22.34***
		Female	28.2	30.2	41.3	43.2	45.4	46.2	48.4	***40.11***
		Mean	***21.7***	***23.3***	***29.8***	***33.7***	***35.15***	***36.2***	***39.8***	
C. carne	*Larval stage*	1st	10.2	11.4	18.4	15.2	17.2	15.4	16.8	***14.94***
		2nd	30.2	35.2	40.2	47.8	42.2	44.6	44.8	***40.71***
		3rd	60.8	75.4	77.2	82.6	90.2	84.6	86.4	***79.6***
		Mean	***33.73***	***40.67***	***45.27***	***58.53***	***49.87***	***48.2***	***49.33***	

Table (2): **"F" values and their significant levels between different variance sources and the corresponding L.S.D. of larval experiments.**

	C. undecimpunctata		*Ch. bipustulatus*		*C. carnea*	
	"F"	L.S.D.	"F"	L.S.D.	"F"	L.S.D
Starvation(hrs.)	4.93**	6.47	12.01**	5.36	7.45**	6.09
Instars	347.01**	4.89	408.82**	4.06	523.97**	3.99

* sig .at 5% level
**sig .at 1% level

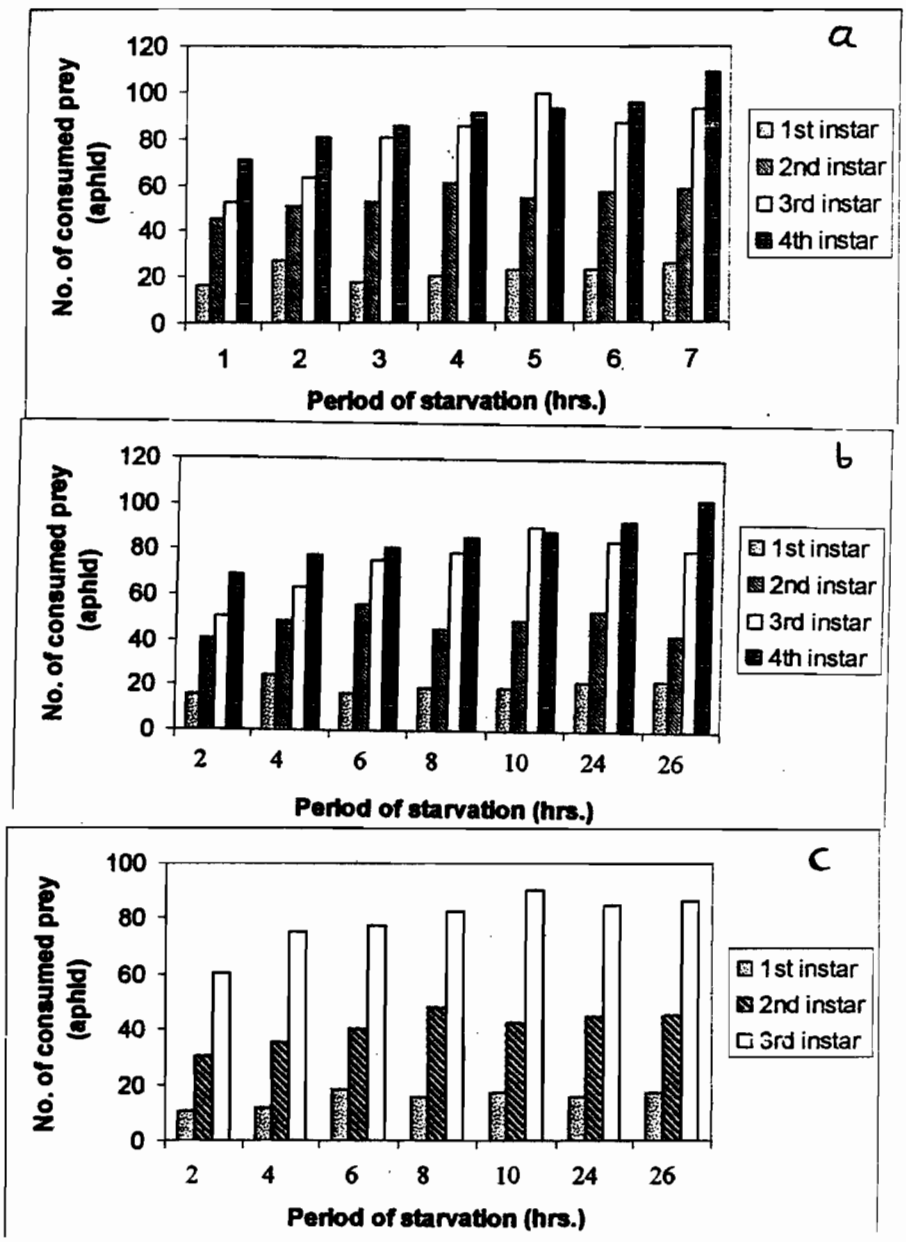

Fig. (1): The relation between period of starvation and average number of consumed prey in larval stage for:
a- *C. undecimpunctata* b- *Ch. bipustulatus* c- *C. carnea*

In all cases, the obtained "F" values showed a highly significant difference between periods of starvation and starved instars of larvae.

According to the calculated L.S.D., starvation periods could be grouped for each the predators' larvae into the following interacting groups as in Table (3) whereas efficiencies of predation of the larval instars are grouped in Table (4).

Table (3): Grouping the efficiency of starvation periods of the three predators' larvae according to the L .S .D.

C. undecimpunctata			*Ch. Bipustulatus*			*C. carnea*		
Starv. Periods (hours)	*Av. cons. aphids*	*Groups*	*Starv. Periods (hours)*	*Av. cons. aphids*	*Groups*	*Starv. Periods (hours)*	*Av. cons. aphids*	*Groups*
26	70.95	A	24	63.15	A	10	49.87	A
10	66.9	AB	26	61.8	AB	26	49.33	A
24	65.4	AB	10	61.75	AB	8	48.53	A
8	64.0	BC	8	57.5	BC	24	48.2	A
6	58.9	CD	6	57.1	BC	6	45.27	AB
4	55.1	D	4	53.4	C	4	40.67	B
2	54.9	E	2	43.85	D	2	33.73	C
L.S.D.	*6.74*		*L.S.D.*	*5.36*		*L.S.D.*	*6.09*	

Table (4):Grouping the efficiency of larval instars in consuming aphids as indicated by the L.S.D.

C. undecimpunctata			*Ch. bipustulatus*			*C. carnea*		
Instars	*Av. cons. aphids*	*Groups*	*instars*	*Av. cons. aphids*	*Groups*	*instars*	*Av. cons. aphids*	*Groups*
1st	21.6	A	1st	19.71	A	1st	14.94	A
2nd	53.6	B	2nd	47.91	B	2nd	40.71	B
3rd	79.8	C	3rd	74.71	C	3rd	79.6	C
4th	89.0	D	4th	85.14	D			
L.S.D.	*4.89*		*L.S.D.*	*4.06*		*L.S.D.*	*3.99*	

Finally, the successive four larval instars of C. *undecimpunctata* showed maximum response at 4h, 8h, 10h and 26h of starvation, where the average numbers of consumed aphids were 26.8, 60.4, 99.2 and 108.6 / larvae, respectively. In case of *Ch. bipustulatus*, the periods of starvation which gave maximum response were 4h., 6h., 10h. and 26h. of starvation, where the average numbers of consumed aphids / larvae were 24.4, 56.2, 90.4 and 102.4 for the four larval instars. While *C. carnea* showed maximum response at starvation periods of 6, 8 and 10h., where the average numbers of consumed aphids / larvae were 18.4, 47.8 and 99.2 for the three successive larval instars. Results also showed that all predators' larvae showed its least response at 2hr of starvation.

B: Predacious efficiency of adults

Table (1) and Fig (2) also showed the average numbers of consumed aphids / adult for both sexes of C. *undecimpunctata* and *Ch. bipustulatus*.

The maximum response of *C. undecimpunctata* adults are shown after 26h of starvation, since the average number of consumed aphids for male and female were 35.2, 55.2, respectively. On the other hand, the corresponding consumed aphids by adults of *Ch. bipustulatus* were 31.2 and 48.4, respectively.

Results, in general, also indicated a retarded relationship between the number of consumed aphids and period of starvation. On the other hand, female adults, of both predators, consumed more aphids than males.

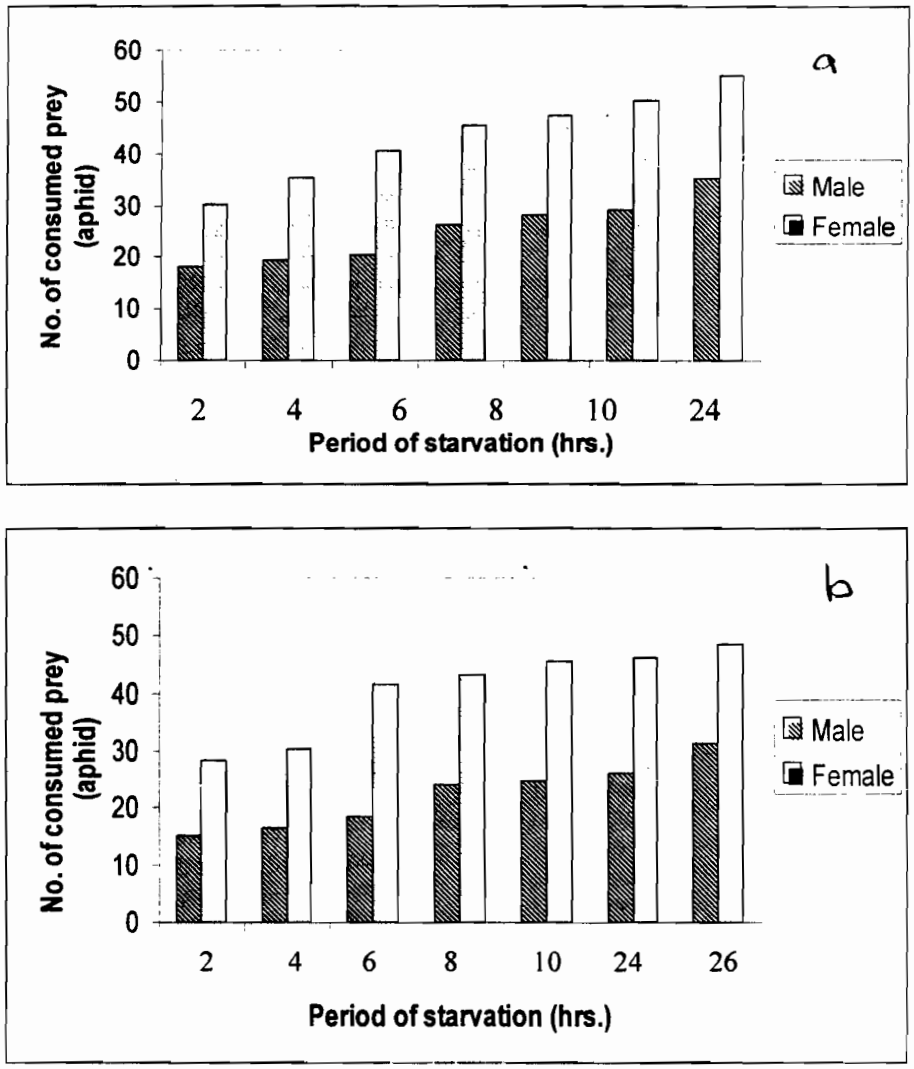

Fig. (2): The relation between period of starvation and average number of consumed prey in adult stage (male and female) for:
a- *C. undecimpunctata* **b- *Ch. bipustulatus***

The obtained "F" values. Results on adults are summarized in Table (5) showed a highly significant differences between period of starvation and starved sexes of adults.

Table (5): "F" values and their significant values between different variance sources and the corresponding L.S.D. of adult experiments.

	C. undecimpunctata		*Ch. Bipustulatus*	
	"F"	L.S.D.	"F"	L.S.D.
Starvation (hours)	12.8**	5.83	8.85**	6.33
Adult sexes	136.53**		112.14**	

* sig .at 5% level
** sig .at 1% level

Results showed that, larval instars and periods of starvation of *C. undecimpunctata*, *Ch. bipustulatus* and *C. carnea* larvae, as well as, the adults (male and female) of *C. undecimpunctata* and *Ch. bipustulatus* affect the predation efficiency that can be clearly observed through the statistical analyses which showed very high significant differences for each predator.

These results also agree with that obtained by many authors. Sengonca and Kranz (2001) stated that the adult lady beetle *Coccinella septempunctata* is considered as an important biological control agent after six hours of starvation for adults.

Starved female beetles and larvae, spent a greater proportion of time while it is feeding (Huck, 1991).Zou-Yunding *et al.* (1997) recorded that the searching behavior of larvae of *Harmonia axyridis* (Coccinellidae) influenced by the degree of starvation.

In 2000, Sun *et al.* noticed that predator potentials increased after starving for 24 hr. .The adult beetle of *C. septempunctata* increased consumption for more than 70 aphids per day when 220 aphids per m^2 were supplied to it. Larvae of *Cryptolaemus montrouzieri* (Coccinellidae) showed maximum response towards prey from the first until fourth instar after 4, 8, 12 and 12hr of starvation (Sengonca *et al.*, 1995).They added that the larvae of *C. carnae* reached the maximum efficiency after 4, 8 and 12hr of hunger for the three instars, Ferran and Dixon (1993) found that the behavior of lady-bird larvae depends upon many factors to success in catching prey such as age and period of hunger.

On practical point of view, for each biological control program, it is very important to starve larvae of any predator before release in the field to increase their nutritive potential, taking into consideration the period of starvation.

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زيادة الكفاءة الإفتراسية لثلاثة مفترسات حشرية عن طريق التجويع.

ليلى عبد الستار عبد الله البطران
قسم الحشرات الإقتصادية - كلية الزراعة - جامعة المنصورة

استهدفت الدراسة تقيم أثر التجويع لفترات مختلفة (٢-٤-٦-٨-١٠-٢٤- ٢٦ساعة) على زيادة الكفاءة الافتراسية للأعمار المختلفة لليرقات و الحشرات الكاملة لكل من *C. undecimpunctata*, *Ch. bipustulatus* , بالإضافة إلى اليرقات فقط من حشرات أسد المن *C. carnea* أجريت الدراسة المعملية فى قسم الحشرات الاقتصادية خلال صيف ٢٠٠٠ وقد أوضحت النتائج مايلى:

فى كل الأعمار اليرقية لحشرة *C. undecimpunctata* كانت اقصى استجابة لافتراس حشرات المن بعد ٤، ٨، ١٠، ٢٦ساعة من التجويع للإعمار الأربعة اليرقية(٢٦,٨، ٦٠,٤، ٩٩,٢، ١٠٨,٦حشرة لليرقة على التوالى), اما الحشرات الكامله من كلا الجنسين فقد بلغ اقصى استجابة لها عندما جوعت ٢٦ ساعة و كان متوسط ما افترسته٣٥,٢،٥٥,٢ لكلا الجنسين على التوالى.

اما فى حشرة *Ch. bipustulatus* فقد بلغ اقصى استجابة لإفتراس حشرات المن ٤، ٦، ١٠، ٢٦ ساعة من التجويع للأعمار الأربعة اليرقية إذ وصل متوسط الافتراس إلى ٢٤,٤، ٥٦,٢، ٩٠,٤ ، ١٠٢,٤ حشرة لليرقة على التوالى أما أقصى استجابة للحشرات الكاملة (ذكور و إناث) فقد أمكن الحصول عليها بعد فترة تجويع ٢٦ ساعة إذ بلغ ٣١,٢ و ٤٨,٨لكلا الجنسين على التوالى.

وبالنسبة للمفترس الثالث *C. carnea* فقد كانت اقصى استجابة لإفتراس اليرقات لحشرات المن هى عند ٦، ٨، ١٠ ساعات من التجويع للأعمار اليرقية المتتابعة على التوالى إذ بلغ متوسط ما افترسته ١٨,٤، ٤٧,٨، ٩٠,٢ على التوالى.

أظهر تحليل التابين لنتائج الدراسة وجود فروق معنوية بين عدد ساعات التجويع المختلفة و فروق معنوية أيضا بين كفاءة الأعمار اليرقية لكل مفترس على حدة . كما ظهر أيضا أن عدد ساعات التجويع لها تأثير واضح فى زيادة الكفاءة الافتراسيه للمفترسات الثلاثة سواء كانت يرقات او حشرات كاملة و بالتالى يمكن الاستفادة التطبيقية من هذه الدراسة (فى أى من برامج المكافحة الحيوية) عن طريق تجويع الطور المفترس (سواء كان حشرة كاملة او يرقات) قبل إطلاقها لزيادة الكفاءة الافتراسية و بالتالى زيادة الاستفادة منها بصورة أكبر إذا ما قورنت بالحشرات التى لم يتم تجويعها.