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INTRA-SPECIFIC COMPETITION AND CANNIBALISM IN THE LADYBIRD BEETLE, *Coccinella undecimpunctata* L. (COLEOPTERA: COCCINELLIDAE)

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ABSTRACT

Investigation of the intra-specific competition of different developmental stages of *Coccinella undecimpunctata* L. was done on scarcity of food and different diet combinations. There was indiscriminate egg cannibalism among the larvae and adults of their own species. The scarcity of food was not the only reason for cannibalism. The fourth instar larvae were more voracious while feeding on eggs as well as on the first instar larvae as compared with the other three larval instars. The increasing numbers of egg consumption by adults was also related to their egg production and the length of the oviposition period. It is concluded that cannibalism increased the survivorship and shortened the developmental period of *C. undecimpunctata*.

INTRODUCTION

The intra-specific competition and cannibalism in coccinellids is mainly due to scarcity of aphid prey and consequently predator starvation (Rahim Khan *et al*., 2003). The cannibalistic feeding appears as a mean of preserving their race in case of shortage of their natural diet (Dixon, 1959 and Brown, 1972). Usually the eggs and young larvae are more vulnerable to cannibals as compared with older larvae and adults (Agarawala and Dixon, 1992). The older larvae and adults pose a threat to eggs and younger larvae. The cannibalism rate may increase when their food is decreased (Polis, 1981 and Cottrell and Yeargan, 1999) but some other species like *Hormonia axyridis* shows the cannibalistic behavior even when the food is abundant (Wanger and Wise, 1996; Wanger *et al*., 1999 and William *et al*., 2000). The prey quality may have low food value so that predator may use the egg masses as to accumulate the valuable resource. The possibilities of eliminating toxic prey or low quality compounds of food source were seemed to be the strategies of cannibalistic behavior of coccinellids and their ecological advantages are not quite clear.

The objective of the present study is to evaluate the intra-specific competition and cannibalistic behavior of *C. undecimpunctata* and its impact on the growth and survival of cannibals for mass rearing.

MATERIALS AND METHODS

The coccinellid species *Coccinella undecimpunctata* L. was reared in Entomological Laboratory of National Research Center, Dokki, Cairo at a temperature of 25±2^{o}C and 65±5% RH on melon aphid (*Aphis gossypii* Glover) infesting cucumber leaves. The experiments were performed to investigate the value of the intra-specific competition and cannibalism for the survival of the predator species and its impact on their mass rearing.

Ten coccinellid larvae were reared individually in plastic cups provided with sufficient numbers of aphids on cucumber leaves to avoid

cannibalism and serve full growth for each one. Until pupation took place, these larvae were provided daily with a number of aphids according to their consumption rates (Tawfik *et al*, 1973). The plastic cups were then covered with muslin by the aid of rubber bands. Prey consumption of the larvae, duration and their mortality percent were recorded. The pre-pupae were allowed to pupate in clean plastic cups. The pupae obtained were held in glass jar 6x6x10 cm covered with muslin. Aphid infested cucumber leaves were placed daily into the jar to provide the beetles with sufficient meals. Leaves carrying newly deposited coccinellid eggs were collected daily and maintained in another jar.

The same procedures were performed with the half of the aphid amounts with replacing aphids with coccinellid eggs or newly hatched *C. undecimpunctata* larvae.

Prey preferences were evaluated among the variables of aphids, eggs and larvae. The numbers of cannibalized eggs and larvae were recorded in the presence and absence of the aphid prey. The data were analyzed using Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

The fourth instar larvae were seemed highly voracious and consumed higher number of eggs. However, the female appeared to be more reluctant in consuming eggs as compared to the larva or male counterparts. It was inversely related to the aphid abundance (Table 1).

In the presence of aphids and the eggs no larva was cannibalized by the fourth instar larvae and adult females while the adult males ate the first instar larvae at the average rate of 15.7 and 18.3 in presence of aphids and eggs, respectively.

Table (1): Food consumption of *C. undecimpunctata* larvae and adults.

Prey/diet		Larval instar				Adult	
		1st	2nd	3rd	4th	Male	Female
Aphids[1]		19.3 ± 2.1a	41.4 ± 5.3a	68.2 ± 6.2a	130.4 ± 6.6a	105.6 ± 5.2a	113.4 ± 6.7a
Eggs[2]		15.7 ± 4.0a	39.6 ± 3.7a	74.5 ± 4.4a	119.1 ± 8.5a	126.3 ± 7.3a	97.8 ± 4.7a
1st instar larvae[3]		0.9 ± 0.2a	2.3 ± 0.4a	7.4 ± 1.2a	33.3 ± 2.7a	39.7 ± 3.6a	45.3 ± 4.8a
Eggs with aphids	Aphids[1]	8.9 ± 1.1b	20.7 ± 2.3b	33.3 ± 4.7b	77.3 ± 5.2b	55.5 ± 3.8b	54.9 ± 3.3b
	Eggs[2]	0.0c	0.0c	2.2 ± 1.3c	13.6 ± 6.9c	42.3 ± 3.5c	66.3 ± 7.2c
Larvae with aphids	Aphids[1]	9.1 ± 1.5b	19.9 ± 3.6b	34.0 ± 3.9b	75.5 ± 4.8b	55.9 ± 4.3b	54.0 ± 4.6b
	1st instar larvae[3]	0.0b	0.0b	0.0b	0.0b	15.7 ± 6.1b	0.0b
Eggs and larvae	Eggs[2]	8.8 ± 2.6b	17.8 ± 3.1b	36.8 ± 4.6b	66.6 ± 3.1b	58.9 ± 4.4bc	83.4 ± 7.1b
	1st instar larvae[3]	0.0b	0.0b	0.0b	0.0b	18.3 ± 3.2b	0.0b

Different letters between similar raws (1, 2 and 3) indicate a significant difference (Duncan, 1955).

To measure the life span and fertility of females, they were fed on various combinations of coccinellid eggs, larvae and natural diet. Slight difference in the adult life span occurred between different treatments where it ranged between 33.1 and 39.7 days in females and between 22.6 and 27.5

days in males. The average oviposition periods increased significantly with egg consumption (Table 2).

Egg production increased significantly with increasing the rate of egg cannibalism where it was 541.4 eggs/female on utilizing the eggs of their own species. Consuming a combination of *C. undecimpunctata* eggs and other prey (larvae or aphids) resulted in significantly higher number of deposited eggs per coccinellid female than utilizing natural diet or coccinellid larvae.

The impact of different diets was unclear on the hatchability of *C. undecimpunctata* eggs where it ranged between 70.5 and 78.0% (Table 2).

Table (2): Fecundity and hatchability of *C. undecimpunctata* under the effect of different diets.

Prey/diet	Adult longevity			Average longevity		No. of deposited eggs/female	Hatchability %
	Pre-oviposition period (days)	Oviposition period (days)	Post oviposition period (days)	Female	Male		
Aphids	3.4 ± 0.3a	25.3 ± 3.1b	5.2 ± 1.3a	33.9 ± 4.6b	27.5 ± 3.3a	368.8 ± 12.4c	76.5 ± 1.8a
Eggs	1.2 ± 0.2c	35.3 ± 3.3a	3.2 ± 2.0b	39.7 ± 5.3a	23.8 ± 3.0a	541.4 ± 14.6a	70.5 ± 1.1a
1st instar larvae	2.5 ± 0.3b	23.7 ± 2.4b	6.9 ± 2.1a	33.1 ± 4.7b	22.6 ± 2.9a	355.6 ± 16.0c	77.3 ± 1.5a
Eggs with aphids	2.3 ± 0.1b	31.8 ± 2.2a	3.8 ± 2.5b	37.9 ± 4.9a	25.4 ± 3.5a	416.6 ± 14.8b	78.0 ± 1.6a
Larvae with aphids	3.5 ± 0.2a	26.1 ± 2.1b	7.4 ± 1.7a	37.0 ± 5.2a	24.3 ± 4.2a	367.0 ± 12.2c	74.8 ± 1.5a
Eggs and larvae	2.1 ± 0.2b	34.3 ± 2.7a	2.5 ± 1.1c	38.9 ± 4.6a	23.9 ± 4.8a	402.2 ± 18.4b	75.6 ± 1.6a

Different letters between raws indicate a significant difference (Duncan, 1955).

These findings are comparable with those of Rahim Khan *et al*. 2003 who stated that the adults and fourth instar larvae of *C. septempunctata* cannibalize some percentage of its own eggs even in the presence of few numbers of aphid prey. On the other hand Agarawala and Dixon (1992) mentioned that as there are apparently no penalties associated with eating conspecific eggs, one would expect cannibalism to occur even when aphids are abundant.

In order to reduce the risk of cannibalism, adults should synchronize the oviposition closer to the aphid colony so that the newly hatched larvae will not be victimized by the older larvae. On the positive side cannibalism improves the chances of surviving the predator to ensure further availability of food when aphids are scarce.

The intra-specific competition and cannibalism occur in *C. undecimpunctata* because of scarcity of the natural diet (El-Khawass, 1999 and Santi and Maini, 2007), but in the presence of aphid prey, egg cannibalism was also seen common.

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التنافس بين أفراد النوع الواحد والافتراس الذاتي في خنفساء أبو العيد ذو الآحدي عشرة نقطة

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تمت دراسة التنافس بين أفراد النوع الواحد والافتراس الذاتي للأطوار المختلفة من حشرة أبي العيد ذي الإحدى عشرة نقطة *Coccinella undecimpunctata* مع ندرة الوجبة الطبيعية لها وهي حشرة من البطيخ *Aphis gossypii*. وظهر هناك افتراس ذاتي للبيض من قبل الحشرات البالغة (الخنافس) والأطوار اليرقية الكبيرة (العمر اليرقي الرابع). كما أظهرت النتائج أن نقص الغذاء ليس هو السبب الوحيد للأفتراس الذاتي والعمر اليرقي الرابع كان أكثر شراهة لافتراس البيض والعمر اليرقي الأول. كما أظهرت الدراسة أن زيادة افترس البيض من قبل الحشرات الكاملة مرتبط أيضا بكميات البيض الموضوع وطول فترة وضع البيض وهذا يوضح أن ظاهرة الآفتراس الذاتي تزيد بزيادة العمر وتنقص من فترة التطور لحشرة أبو العيد ذو 11 نقطة. ويمكن القول بأن الافتراس الذاتي زاد من فرصة البقاء وقلل فترة نمو حشرة أبي العيد ذي الإحدى عشر نقطة.

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