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Comparative biological aspects of the two coccinellid species; *Coccinella undecimpunctata* L. and *Hippodamia convergens* Guer. under laboratory conditions

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ABSTRACT

Comparative study of major biological aspects; duration, feeding capacity, longevity and fecundity of the two common coccinellid species; *Coccinella undecimpunctata* L. and *Hippodamia convergens* Guer., when fed on the cowpea aphid species, *Aphis craccivora* Koch. was carried out under laboratory conditions. Total larval durations of *C. undecimpunctata* were 13.6±0.08, 13.02±0.12, 11.2±0.12 and 10.18±0.09 days and those of *H. convergens* were 12.91±0.17, 12.04±0.16, 10.78±0.21 and 8.84±0.26 days, when they were fed on 1st, 2nd, 3rd and 4th nymphal instars of *A. craccivora*, respectively. Feeding capacity of the larval stage of *C. undecimpunctata* was; 1440.68±12.17, 1149.36±9.65, 809.65±6.68 and 661.14±4.74 nymphs while that of *H. convergens* was; 1107.43±9.61, 786.33±8.60, 533.20±5.65 and 370.25±3.79 nymphs, when larva of each species was fed on each of the four nymphal instars of *A. craccivora,* respectively. Total feeding capacity of the two predatory adults was the highest during the ovipositonal period; it ranged between 207 – 263 nymphs/adult/day. Female's longevity averaged 78.05±2.26 and 48.80±1.66 days for *C. undecimpunctata* and *H. convergens,* respectively. When adults of *C. undecimpunctata* and *H. convergens* were fed on *A. craccivora* nymphs, a single mated female deposited 880.85 (742-983) and 729 (589-851) eggs from which hatchability percentages were 81 and 94%, respectively.

Key Words: Biological aspects, *Coccinella undecimpunctata*, *Hippodamia convergens, Aphis craccivora,* laboratory conditions.

INTRODUCTION

Predators belonging to family Coccinellidae, comprise a group of the most active predatory species, that feed on different sucking pests including aphids, whiteflies, jassids and mites as well other small insects. This Family gained an interested role as important group of predators in the biological control of insect pests attacking different crop plants.

Several coccinellid species were recorded on different field, vegetable and fruit crops in Egypt. The aphids, *A. craccivora, A. gossypii* and *Myzus persicae* constitute the food essential for the majority of Coccinellidae (Saharaoui *et al.*, 2001).

Many authors studied biological aspects of the coccinellids in Egypt; Hamed and Hassanein (1984) studied prey consumption of *Coccinella undecimpunctata* L. on aphids, Mohamed and Mahmoud (1986) assessed the rates of predation by field collected larvae of *C. septempunctata, C. novemnotata* and *C. undecimpunctata* on *Aphis faba* populations, El-Batran *et al.* (1995) studied the biological parameters of the coccinellid species *Adalia bipunctat*a on different preys and Hafez (2001) studied durations, longevity, ovipositional periods, fecundity and prey consumption of *Hippodamia tredecimpunctata* on the greenbug, *Schizaphis graminium.*

Field studies carried out at Moshtohor district, Qualubia Governorate revealed that the two coccinellid species; *C. undecimpunctata* and *H. convergens* were the most abundant predatory species not only among the coccinellid group but also among all other predatory species recorded in cotton, maize, faba bean and clover fields in seasons 2002-2004 (Ismail, 2006).

The present study aimed to compare major biological aspects; duration, feeding capacity, longevity and fecundity of the two common coccinellid species; *C. undecimpunctata* and *H. convergens* under laboratory conditions as bases for the mass rearing of these species.

MATERIALS AND METHODS

Rearing of aphids

The cowpea aphid, *Aphis craccivora* Koch. was the prey species used for feeding the two predaceous coccinellids under investigation. *A. craccivora* individuals were collected from faba bean fields in Qalubiya Governorate. Stock culture of the aphid species was reared under the laboratory conditions of 23±2° C and

65±5% RH, on faba bean plants in plastic pots.

Rearing of coccinellids

4-5 pairs (males and females) of either *C. undecimpunctata* or *H. convergens* were placed in plastic jars (20 x 10 cm) and provided with adequate numbers of *A. craccivora* individuals. The jars were covered with muslin and kept in position by rubber bands and maintained under the laboratory conditions of 23±2° C and 65±5%RH. The leaves of faba bean seedlings in the pots carrying the deposited eggs were cut and transferred to other clean jars and kept until hatching. Fresh hatched larvae were provided daily with adequate numbers of aphids as food until pupation. Pupae were subsequently, kept until adult's emergence.

Biological studies on *C. undecimpunctata* and *H. convergens*:-

All experiments were carried out under the laboratory conditions of 23±2° C and 65±5% R.H.

Duration of immature stages of coccinellids

1- **Egg stage:** Groups of 30 eggs each of the two species were placed in a Petri-dish (15cm diameter) until hatching. Daily total numbers of hatched eggs were counted and percentages of hatchability for both predators were calculated. These experiments were replicated 4 times.

2- **Larval and pupal stages**: Groups of four replicates, each of 22 newly hatched larvae of each predatory species, were allowed to complete their development until pupation. Durations of each larval instar, total larval and pupal periods were recorded. Percentages of larval and pupal mortalities were also estimated.

Feeding capacity of larvae

Larvae of each instar, from each predatory species, were separately supplied daily by adequate number of one of the four nymphal instars of *A. craccivora*. 22 predatory larvae were individually placed in glass jars (4.5 cm. diameter) and used as replicates.

The following procedure was followed in all experiments:-

- The four aphid nymphal instars were separated by age and size by dropping them from the infested faba bean seedlings on a white paper.
- Each glass jar was provided initially by 50 nymphs from each instar of *A. craccivora* per larva of both predatory species. This number was increased daily to 70, 90, 110, 130, 150, 170, 190, 210, 230, 250, 270 and 290 aphid individuals.
- Total number of consumed aphids per larva, per instar and per day was daily counted until pupation.

Feeding capacity of adults

Four groups each consisted of 20 freshly emerged females were used, individually, as replicates. Each female was provided by 350 individuals (according to primary experiments), of each of the first, second, third and fourth nymphal instars of *A. craccivora*, respectively, for only one day during the three ovipositional periods; pre-oviposition, oviposition and post-oviposition. The total counts of consumed aphids were recorded on the next day.

Effect of food kind on longevity and fecundity of *C. undecimpunctata* and *H. convergens* adults

Longevity and fecundity of adults of both species were estimated when they fed on *A. craccivora,* sugar solution and when they were kept starved. No. of replicates were 20 pairs. Obtained data were recorded.

Sex-ratio

The sex-ratios (males: females) among the emerged adults of the two predatory species were estimated. Four groups, each of 22 replicates were used. The two sexes were separated according to the following characteristics; females are larger in size than males, posterior parts of the females are more rounded than males, and the two eyes of females are similar in size than those in males, while the distances between the two eyes of females are longer than males.

Fecundity and percentages of eggs' hatching

Fecundity of the adult females of both predatory species was estimated under the same laboratory conditions. Total number of eggs laid/female during the ovipositional period was counted and recorded. Percentages of hatchability among the deposited eggs were also estimated. Twenty replicates /predator were used.

Statistical analysis:

Statistical analysis of the data was carried out using ANOVA.

RESULTS AND DISCUSSION

A comparative experiment was carried out to weight different nymphal instars of *A. craccivora* to estimate volume of consumption by each larval instar and the adults of the two coccinellid species. Obtained data are summarized in Table (1). Normally, the weight of nymphs increased as the nymphs grew older to subsequent instars. The lightest weight was that of the 1st intar nymphs (0.0034 gm/50 nymphs) while the heaviest was the 4th instar (0.0213 gm/50 nymphs).

Durations of immature stages

Incubation period of eggs

Results given in Table (2) show that the incubation period of eggs of *C. undecimpunctata* and *H. convergens* under the abovementioned laboratory conditions averaged 4.28±0.02 and 4.32±0.12 days, respectively. Statistical analysis showed no significant difference between both species.

Larval, pupal durations and total developmental period

Larvae of the two coccinellids molt through four larval instars.

C. undecimpunctata

As shown in table (2), the means of first larval instar duration were 2.8±0.02, 2.71±0.04, 1.92±0.03 and 1.87±0.04; the 2nd: 2.89±0.02; 2.74±0.03, 2.66±0.03 and 1.96±0.03; the 3rd: 3.02±0.03, 2.85±0.04, 2.82±0.04 and 2.78±0.04; and the 4th: 4.89±0.05, 4.73±0.07, 3.74±0.09 and 3.57±0.09 days by feeding on the 1st, 2nd 3rd and 4th nymphal instars of *A. caraccivora,* respectively.

The averages of total duration of the larval stage were 13.6±0.08, 13.02±0.12, 11.2±0.12 and 10.18±0.09 days, when fed on the respective nymphal instars of *A. craccivora*. Total larval periods became gradually shorter as the offered aphid nymphs were of older instars.

As for the pupal stage, it elapsed 5.72±0.09, 5.62±0.09, 5.64±0.09 and 5.62±0.08 days when the larvae were fed on the successive aphid nymphal instars, respectively (Table 2). Correspondent total developmental periods were 23.60±0.27, 22.49±0.27, 21.13±0.29 and 19.95±0.13 days, respectively (Table 2).

Table (1): Mean weights/50 individuals of different nymphal instars of *Aphis craccivora*.

Nymphal instars	Mean weight / 50 individuals (gm)
1st	0.0034 ± 0.0002
2nd	0.0077 ± 0.0006
3rd	0.0156 ± 0.0022
4th	0.0216 ± 0.0004

Table (2): Mean durations (days) of immature stages of *Coccinella undecimpunctata* and *Hippodamia convergens* reared on different nymphal instars of *Aphis craccivora* under laboratory conditions.

Predatory species	Eggs	Prey (nymphal instars)	Larvae				Total larval stage	Pupae	Total Developemental period
			1st	2nd	3rd	4th			
C. undecimpunctata	4.28±0.02 (3.29-5.08)	1st	2.81±0.02 (2.67-2.98)	2.89±0.02 (2.72-3.00)	3.02±0.03 (2.78-3.17)	4.89±0.05 (4.53-5.20)	13.60± 0.08 (12.94 -14.08)	5.72±0.09 (5.33-6.30)	23.6±0.27
		2nd	2.71±0.04 (2.49-2.96)	2.74±0.03 (2.55-2 .98)	2.85±0.04 (2.63-3.15)	4.73 ± 0.07 (4.32-5.15)	13.02 ± 0.12 (12.29-14.11)	5.62 ± 0.09 (5.21-6.25)	22.49±0.27
		3rd	1.92±0.03 (1.70-3.10)	2.66±0.03 (2.50-2.90)	2.82±0.04 (2.60-3.10)	3.74 ± 0.09 (3.15-4.17)	11.12 ± 0.12 (10.20-12.04)	5.64±0.09 (5.30-6.35)	21.13±0.29
		4th	1.87±0.04 (1.65-2.15)	1.96 ± 0.03 (1.80-2.15)	2.78±0.04 (2.55-3.12)	3.57 ± 0.09 (3.05-4.12)	10.18 ± 0.09 (9.48-10. 73)	5.62±0.08 (5.24-6.25)	19.95±0.31
H . convergens	4.32±0.12 (4.04-4.67)	1st	2.89 ± 0.02 (2.75-3.05)	2.86±0.02 (2.77-3.10)	2.93 ± 0.03 (2.79-3.70)	4.23±0.10 (3.70-5.00)	12.91± 0.17 (12.28-13.49)	4.32±0.12 (3.60-5.00)	21.55±0.17
		2nd	2.82 ± 0.02 (2.64-2.97)	2.82±0.02 (2.70-3.02)	2.98±0.07 (2.76-3.70)	3.42±0.11 (2.81- 4.20)	12.04± 0.16 (11.06-13.13)	4.42±0.13 (3.65-5.20)	20.80±0.16
		3rd	1.90±0.02 (1.77-2.10)	2.73±0.02 (2.61-2.95)	2.83±0.02 (2.70-2.97)	3.31 ± 0.11 (2.78 : 3.97)	10.78 ± 0.21 (9.98-11.49)	4.45±0.13 (3.80-5.30)	19.49±0.21
		4th	1.86±0.03 (1.70-2.05)	1.91±0.02 (1.80-2.10)	1.97±0.02 (1.86-2.15)	3.10 ± 0.09 2.70 - 3.02	84.84 ± 0.26 (8.42-9.67)	4.36 ± 0.11 (3.70-5.10)	17.56±0.26

Obtained data showed that, there were inverse relationship between the prey and larval period of *C. undecimpunctata* (shorter larval duration by feeding on nymphs of older instars).

H. convergens

As shown in the mentioned table, the respective mean total durations of predator's 1st larval instar were: 2.89±0.02, 2.82±0.02, 1.90±0.02 and 1.86±0.03; the 2nd: 2.86±0.03, 2.82±0.02, 2.73±0.02 and 1.91±0.02; the 3rd: 2.93±0.03, 2.98±0.07, 2.83±0.02 and 1.97±0.02; and 4th larval instar were: 4.23±0.10, 3.42±0.11, 3.3±0.11 and 3.10±0.09 days when each was fed on the 1st, 2nd, 3rd and 4th nymphal instars of *A. craccivora,* respectively. The average total larval durations were 12.91±0.17, 12.04±0.16, 10.78±0.21 and 8.84±0.26 days, when larvae were fed on the same nymphal instars of *A. craccivora,* respectively. The inverse relationship between age of the nymphal instars of *A. craccivora* and durations of larval instars of *C. undecimpunctata* was also confirmed in case of *H. convergens.* By feeding in each of the 4 nymphal instars of *A. craccivora,* the pupal periods were 4.32±0.12, 4.42±0.13, 4.45±0.13 and 4.36±0.11 days, respectively (Table 2).

The previous data revealed that no distinct differences between the two species, *C. undecimpunctata* and *H. convergens* in the durations of the incubation period of eggs and pupal stage. While in case of the larval stage, there were differences between the two species specially, the 3rd and 4th larval instars, the total larval and total development periods. The duration of *H. convergens* was relatively shorter than *C. undecimpunctata.*

Lind (1988) revealed that the durations of *H. convergens* larval and pupal stages lasted for 5, 20 and 5 days, respectively when larvae were fed on aphids. El-Hoseiny (2001) found that the average period of the larval stage lasted 10.80±1.32 and 9.24±1.01 days for *C. undecimpunctata* and *H. tridecimpunctata* at 27° C and 65-70% R. H. when reared on *A. craccivora,* respectively. Hafez (2001) demonstrated that, at 21.5°C and 63-68% R. H., the average incubation period of *H. tredecimpunctata* eggs was 4.4±0.22 days. The duration of larval and pupal stages were 16.47±0.17 and 8.6±0.19 days, respectively. Khalifa (2005) reported that at 26.4-31.7°C and 66-81% R. H., the mean incubation period of *C. undecimpunctata* eggs averaged 2.2 day, and the four larval instars durations were 1.0±0.12, 1.0±0.13, 1.2±0.28 and 1.4±0.30 days, respectively. The total larval period was 4.6±0.76 and the pupal period was 4.2±0.75 days. The total developmental period of immature stages ranged between 10 to 14 days and averaged 11 days when fed on *A. gossypii.*

Feeding capacity of larvae

C. undecimpunctata:

As shown in table (3), the 1st instar larva fed on 142±2.26, 117.27±1.50, 52.73±0.76 and 37.00±0.85 nymphs; the 2nd instar on 228.41±2.02, 177.59±1.88, 132.14±1.67 and 80.82±1.22 nymphs; the 3rd on 375.18±3.98, 264.41±2.83, 196.65±2.59 and 184.71±1.88 nymphs and the 4th larval instar on 695.10±6.46, 590.10±5.41, 428.10±2.76 and358.57±3.26 nymphs on the 1st, 2nd, 3rd and 4th nymphal instars of *A. craccivora*, respectively. Throughout the total larval stage, the mean of total correspondents were 1440.68±12.17, 1149.36±9.65, 809.65±6.68 and 661.14±4.74 nymphs when larva was fed on the successive nymphal instars of *A. craccivora,* respectively.

Obtained data revealed that the mean total consumption of *A. craccivora* nymphs by different larval instars increased as the larval instar of the predator became older and as the predator's larva was fed on *A. craccivora* nymphs of older instars. Therefore, 4th instar larva of *C. undecimpunctata* fed on the highest number of aphids from all prey instars, reaching about twice those consumed by the 3rd instar, 3.3 times

Table (3): Mean total feeding capacity of different larval instars of *Coccinella undecimpunctata* on different nymphal instars of *Aphis craccivora* under laboratory conditions.

Nymphal instars	Mean total larval consumption				Mean total
	1st	2nd	3rd	4th	
1 st	142.00±2.26 (122-157)	228.41±2.02 (210-246)	375.18±3.98 (348-405)	695.10±6.46 (646-775)	1440.68±12.17 (1350-1557)
2 nd	117.27±1.50 (101-129)	177.59±1.88 (156-193)	264.41±2.83 (235-290)	590.10±5.41 (538-625)	1149.36±9.65 (1030-1226)
3 rd	52.73±0.76 (47-58)	132.14±1.67 (118-142)	196.65±2.59 (168-214)	428.10±2.76 (393-449)	809.65±6.68 (745-851)
4 th	37.00±0.85 (29-43)	80.82±1.22 (71-91)	184.71±1.88 (171-201)	358.57±3.26 (324-385)	661.14±4.74 (611-707)

those consumed by 2nd instar and 5.9 times those consumed by the 1st instar larva. The third instar larva of predator come the next in feeding capacity; about 1.65 that of 2nd insstar and 2.9 times of that of 1st larvae. While the *C. undecimpunctata* 2nd instar larva ranked the third in feeding capacity on *A. craccivora* as it fed on a total number of aphids representing about 1.8 those consumed by one larva of the 1st instar.

H. convergens:

The 1st instar larva of *H. convergens* fed on the mean numbers of 94.33±1.30, 71.23±0.80, 36.29±0.54 and 24.10±0.52 *A. craccivora* nymphs, the 2nd instar consumed 156.90±1.89, 105.57±1.05, 76.62±0.88 and 45.05±0.79 nymphs, the 3rd on 297.86±3.64, 184.86±2.91, 120.85±1.80 and 69.90±1.30 nymphs and the 4th larval instar fed on 558.33±5.17, 424.81±5.20. 299.40±3.60 and 201.40±1.75 nymphs when the predator's larvae were fed on the 1st, 2nd, 3rd or 4th nymphal instars of *A. craccivora,* respectively (Table 4). Throughout the total larval period, the larva fed on the mean numbers of 1107.43±9.61, 786.33±8.60, 533.20±5.65 and 370.25±3.79 nymphs from any of the 4 instars, respectively.

Obtained data revealed that the mean total consumption of *A. craccivora* by a *H. convergens* larva increased as the larval instar of the predator became older and also as the nymphal instars of *A. craccivora* developed to older instars.

Data presented in Table (4) confirmed that the 4th instar larva of *H. convergens* consumed the highest total number of *A. craccivora* nymphs, being about 2.2 times that consumed by the 3rd instar, 3.9 times that consumed by the 2nd instar and 6.6 times than that consumed by the 1st larval instar.

It could be also concluded from the data in tables (3 & 4) that each of the 4 larval instars of *C. uncecimpunctata* fed on more *A. craccivora* nymphs than that consumed by larvae of *H. convergens.* As a general mean, a single *C. undecimpunctata* larva could feed throughout the larval stage on a total number of aphid nymphs (of mixed instars), being about 1.5 times that consumed by a *H. convergens* larva.

Ibrahim (1955) found that, the larvae of *C. undecimpunctata* when fed on *Aphis durantae*, the number consumed during the four larval instars, at an average temperature of 25.5°C were 27.1, 41.6, 70.1 and 270.5, respectively. Compbel and Cone (1999) found that the larvae of *H. convergens* consumed an average of 318 adults of the damson hop aphid (*Rhordon humuli*) during its development at 20°C. El-Hosiny (2001) reported that, the total consumption of larval stage of *C. undecimpunctata* and *H. rtidecimpunctata* was; 626.31±20.93 and 483.4±9.85, respectively. Hafez (2001) found that the consumption rate from *Schizaphis graminum* by *H. tredecimpunctata* increased as larval instars grew older. The highest consumption rate (121.07±3.74 aphid individuals), was recorded by the 4th instar larva. Cardose and Lazzari (2003) found that, the predator, *H. convergens,* especially in the fourth larval instar, showed higher consumption capacity on the aphid *Cinara* spp. nymphs. Khalifa (2005) reported that, a single larva of *C. undecimpunctata* from the 1st, 2nd and 3rd instars consumed the averages of 36.5, 47.6 and 79.8 individuals of the aphid, *A. gossypii* for the three instars, respectively. The 4th larval instar consumed the highest aphid number (107.9 individuals).

Feeding capacity of adult females

C. undecimpunctata

As shown in table (5), the means of daily total numbers of 1st inster *A. craccivora* nymphs consumed by an adult female of *C. undecimpunctata* were; 219.6±1.3, 215.5±1.9 and 172±1.7 nymphs of 1st instar during the pre-ovipositional, ovipositional and post-ovipositional periods, respectively. By feeding on the 2nd

Table (4): Mean total feeding capacity of different larval instars of *Hippodamia convergens* on different nymphal instars of *Aphis craccivora* under laboratory conditions.

Nymphal instars	Mean total larval consumption				Mean total
	1st	2nd	3rd	4th	
1 st	94.33±1.30 (85-104)	156.90±1.89 (144-174)	297.86±3.64 (272-323)	558.33±5.17 (522-604)	1107.43±9.61 (1046-1193)
2 nd	71.23±0.80 (63-78)	105.57±1.05 97-117	184.86±2.91 (159-206)	424.81±5.20 (387-474)	786.33±8.60 (719-849)
3 rd	36.29±0.54 (31-40)	76.62±0.88 (66-82)	120.85±1.80 (108-136)	299.40±3.60 (276-332)	533.20±5.69 (498-580)
4 th	24.10±0.52 (20-28)	45.05±0.79 (40-50)	69.90±1.30 (61-80)	201.40±1.75 (186-217)	340.25±3.79 (318-375)

Table (5): Mean daily total feeding capacity of *Coccinella undecimpunctata* L. adults on different nymphal instars of *Aphis craccivora* under laboratory conditions.

Ovipositional periods	Duration (days)	No. of consumed aphids from different aphid nymphal instars			
		1st nymph	2nd nymph	3rd nymph	4th nymph
Pre-ovipositional period	5.65±0.16 (5 - 7)	219.55±1.32 (209 - 231)	183.40±1.43 (171 - 196)	146.90±1.62 (132 - 162)	105.80±1.22 (98 - 115)
Ovipositional period	63.15±2.12 (45 - 79)	251.50±1.88 (237 - 263)	216.45±1.45 (203 : 228)	179.45±1.81 (167 - 192)	136.55±1.51 (127 - 147)
Post-ovipositional period	9.25 ± 0.25 (8 - 11)	172.40±1.72 (157 - 183)	139.80±1.15 (131 - 149)	113.30±1.36 (102 - 121)	81.50±1.15 (73 - 89)

Table (6): Mean total feeding capacity of *Hippodamia convergens* Guer. adults on different nymphal instars of *Aphis craccivora* under laboratory conditions.

Ovipositional periods	Duration (days)	No. of consumed aphids from different aphid nymphal instars			
		1st nymph	2nd nymph	3rd nymph	4th nymph
Pre-ovipositional period	5.20±0.15 (4 - 6)	183.85±1.41 (174 - 197)	147.50±1.11 (138 - 157)	114.40±1.21 (106 - 125)	83.00±1.33 (73 - 93)
Ovipositional period	36.70±1.39 (25 -47)	219.45±1.65 (207 - 235)	182.30±1.29 (171 - 192)	144.85±1.37 (136 - 156)	108.45±1.69 (98 -121)
Post-ovipositional period	6.95±0.27 (5 - 9)	157.95±1.49 (147 - 169)	121.30±0.91 (116 - 128)	89.50±1.44 (81 - 102)	63.40±1.20 (57 - 68)

nymphal instar, it consumed 183.4±1.4, 216.5±1.5 and 139.8±1.2 nymphs, respectively. In case of offering aphid nymphs of the 3rd instar, it fed on 146.9±1.6, 179.5±1.8 and 113.3±1.4 nymphs, apposed to 105.8±1.22, 136.55±1.51 and 81.5±1.15 nymphs of the 4th instar consumed during the mentioned ovipositional periods, respectively.

***H. convergens*:**

From data presented in table (6), a single mated *H. convergens* female consumed 183.85±1.41, 219.54±1.65 and 157.95±1.49 individuals when fed on *A. ccraccivera* 1st nymphal instar; 147.50±1.11, 182.30±1.29 and 121.30±0.91 individuals of 2nd nymphal instar; 114.40±1.21, 144.85±1.37 and 89.50±1.44 nymphs of 3rd instar and 83.00±1.33, 108.45±1.69 and 63.40±1.20 nymphs of the 4th nymphal instar during one day of the pre-ovipositional, ovipositional and post-ovipositional periods, respectively.

Data in tables (5 & 6) revealed that the means of total feeding capacity of the two predators were the highest during the ovipositonal period, while the lowest numbers consumed were recorded during the post-ovipositional period. On the other hand, the mean total consumption of *A. craccivora* nymphs by an adult female of each of the two predatory species decreased when the offered nymphs for larval feeding grew older.

Hamed and Hassanein (1984) reported that the daily mean prey consumption by *C. undecimpunctata* adult averaged 10.3 nymphs of *Aphis punica*. El-Hosiny (2001) stated that the daily average consumption of *A. craccivora* by *C. undecimpunctata* adults were 138.46±4.56, 152.42±6.37 and 109.75±5.83 during pre-ovipositional, ovipositional and post-ovipositonal periods, respectively. Respective daily average consumption by *H. tridecimpunctata* were; 108.456.25, 1225.57±8.12 and 81.56±4.56, respectively. Khalifa (2005) found that the daily mean number of *Aphis gossypii* nymphs consumed by *C. undecimpunctata* adults under the laboratory conditions (26.4-31.7°C and 66-81% R.H.) was 83.9±6.88/nymphs, while the mean total consumption was 4264.5±76.66 (3383 - 4562) nymphs.

Effect of food kind on longevity and fecundity of *C. undecimpunctata* and *H. convergens* adults

Table (7) shows the longevity and fecundity of *C. undecimpunctata* and *H. convergens* adults (males and females) under the laboratory conditions of 23±2°C and 65±5% R.H. under three regimes of nutrition; *i. e.*, starvation, feeding on 20% sucrose solution and feeding on *A. craccivora*.

Longevity

C. undecimpunctata:

C. undecimpunctata adult male lived for 7.10±0.33, 29.90±1.10 and 53.55±1.32 days opposed to 10.90±0.46, 47.00±1.39 and 78.05±2.26 days for female, in case of starvation, feeding on sugar solution and on *A. craccivora,* respectively.

H. convergens:

Respective longevities of *H. convergens* adult males were; 3.70±0.39, 21.70±0.82 and 39.45±1.30, opposed to 7.20±0.26, 32.10±1.4 and 48.80±1.66 days for females under starvation, feeding on sugar solution and on *A. craccivora* conditions, respectively (Table 7).

Data presented in table (7) showed that starved adults of both species lived for the shortest period (3.7-10.9 days). The two predatory species lived more than four times (21.7-47 days) when they fed on 20% sucrose solution and more than seven folds (48.80 - 78.05) when they fed on *A. craccivora.* Comparing the longevity of both sexes, data in table (7) clarified that in both species, female adults lived about 1.44 times longer than males. *C. undecimpunctata* adults lived about 1.48 times longer than those of *H. convergens.*

In agreement with the present results, Ibrahim (1955) revealed that, generally adult females of *C. undecimpunctata* lived longer than adult males at 26°C. The same author found also that the beetles lived an average of three times as long when they were provided with water only than when starved, about fourteen times when fed on *Aphis durantae* and twenty-one times when fed on mixture of bee honey and water. El-Hosiny (2001) reported that the averages of female longevity of *C. undecimpunctata* and *H. tridecimpunctata* were; 80.52±1.17 and 50.48±6.25 days, respectively. Meanwhile, those of male were; 45.71±4.62 and 41.85±4.16 days, respectively, when fed on *A. craccivora* at 26±2°C and 65-70% R.H. Hafez (2001) found that the adult longevities of *H. tridecimpunctata* were 61.25±6.60 days for males and 52.88±6.77 days for females when fed on the wheat aphid, *S. graminium* at 21.5±0.35°C and 63-68% R. H. Khalifa (2005) stated that the longevities of *C. undecimpunctata* male and female were 45.8±6.51 and 56.2±5.92 days, respectively, when fed on the cotton aphid *A. gossypii* at 26.4-31.7°C and 66-81% R. H.

Fecundity and percentages of egg hatchability:

As shown in table (7), no eggs were deposited by starved *C. undecimpunctata* or *H. convergens* females. By feeding on 20% sucrose solution, a single female of either of the two species deposited only 3.6 (0-9) and 1.9 (0-6) eggs, respectively. In both cases, no hatching occurred. When adults of *C. undecimpunctata* and *H. convergens* were fed on *A. craccivora* nymphs, a single mated female deposited 880.85 (742-983) and 729.2 (589-851) eggs, respectively. The hatchability percentages were 81 and 94%, respectively. From the same table, it is clear that a *C. undecimpunctata* female deposited about 1.2 times number of eggs more than those deposited by *H. convergens* female. Also, females of *C. undecimpunctata* fed on *A. craccivora* lived about 1.6 folds as that of *H. convergens* female adult.

Radriguez and Miller (1995) reported that when *H. convergens* adults were fed on *Acyrthosiphon pisum,* a single female deposited 344 eggs, being fewer than those recorded in the present study. Rao *et al.* (1997) stated that the longevity of adults of both coccinellid predatory species; *Menochilus sexmaculata* and *Verania vincta* increased when they were fed on 10% sucrose followed by honey solution, but no eggs were produced. El-Hosiny (2001) mentioned that the average fecundity of *C. undecimpunctata* and *H. convergens* when fed on *A. craccivora* at 27±2°C and 65-70% R. H. were; 1089±58.58 and 1050.11±102.75 eggs, respectively, being 1.2 and 1.4 times as those recorded in the present study, respectively. Hafez (2001) found that the female of *H. tridecimpunctata* deposited an average of 306.2±38.66 (173-538) eggs throughout an ovipositional period of 40.38±3.27 (26-56) days. Khalifa (2005) revealed that, the total number of eggs laid per female of *C. undecimpunctata* was 468, with an average of 15.3 eggs/ female/ day (at 26.4-31.7°C and 66-81% R. H.).

Table (7): Longevity (days), fecundity and percentages of eggs' hatchability of *Coccinella undecimpunctata* and *Hippodamia convergens* under laboratory conditions.

Diet regimes	*C. undecimpunctata*				*H. convergens*			
	Males	Females			Males	Females		
	Longevity	Longevity	Fecundity	% egg hatchability	Longevity	Longevity	Fecundity	% egg hatchability
Starvation	7.10±0.33 (6 - 8)	10.90±0.46 (8 - 13)	0.00±0.00	0.00	3.70±0.39 (2 - 5)	7.20±0.26 (6 - 8)	0.00±0.00	0.00
Sugar solution 20%	29.90±1.10 (25 - 36)	47.00±1.39 (41 - 53)	3.60±1.06 (0 - 9)	0.00	21.70±0.82 (18 - 25)	32.10±1.14 (29 - 37)	1.90±0.76 (0 - 6)	0.00
Aphis craccivora	53.55±1.32 (46-63)	78.05±2.26 (59 - 94)	880.85±16.20 (742 - 983)	81.00	39.45±1.30 (32-47)	48.80±1.66 (35 - 58)	729.15±20.44 (589 - 851)	94.00

Table (8): percentages of larval mortality, adults' emergence and sex ratio of *Coccinella undecimpunctata* and *Hippodamia convergens* fed on different nymphal instars of *Aphis craccivora* under laboratory conditions.

Biological factors	Predatory species									
	C. undecimpunctata					*H . convergens*				
	Nymphal instar					Nymphal instar				
	1st	2nd	3rd	4th	Mean	1st	2nd	3rd	4th	Mean
%larval mortality	0.00	0.00	0.10	0.05	0.03	0.05	0.05	0.10	0.10	0.07
%Adults emergence	90.91	81.82	90.00	85.71	87.06	95.24	100.00	100.00	90.00	96.34
Sex ratio ♂:♀	1.22:1	1:1	1.57 : 1	1.25: 1	1.24: 1	1.22: 1	1.1: 1	1.5: 1	1.25: 1	1.26 : 1

Percentages of larval mortality and adults' emergence

Table (8) shows the percentages of larval mortality, adults' emergence and the sex-ratio of two coccinellid species when reared on *A. craccivora*.

Percentages of larval mortality and adults' emergence

Table (8) shows the percentages of larval mortality, adults' emergence and the sex-ratio of two coccinellid species when reared on *A. craccivora*.

Larval mortality

By feeding *C. undecimpunctata* larvae on *A. craccivora* nymphs from the 1st, 2nd, 3rd and 4th instars, larval mortality percentages were; 0.00, 0.00, 0.10 and 0.05%., respectively, with a mean of 0.03%. As for *H. convergens* larvae, the corresponding percentages were; 0.05, 0.05, 0.1 and 0.1%, with a mean of 0.07%.

Adults' emergence

As the larvae of both species reached the pupal stage, obtained pupae were kept under the laboratory conditions of 23±2°C and 65±5% R.H. until emergence of adults. The percentages of emergence of *C. undecimpunctata* were 90.9, 81.8, 90 and 85.7%, with a mean of 87.06% when larvae were fed on 1st, 2nd, 3rd and 4th nymphal instars. Corresponding figures for *H. convergens* were; 95.2, 100, 100, 90 and 96.34%, respectively (Table 8).

Mortality rates recorded in the present study were lower than those recorded by El-Hosiny (2001) who recorded the averages of 3.75 and 4.81% for *C. undecimpunctata* and *H. tridecimpunctata*, respectively.

Sex-ratio

As shown in table (8), the sex-ratio (♂:♀) did not vary greatly after feeding the larvae of *C. undecimpunctata* or *H. convergens* on *A. craccivora* nymphs of different instars. The general mean of sex-ratio was about 1.2:1. Males decreased and the sex-ratio reached about 1:1 among adults resulted from larval feeding on the 2nd nymphal instar. On the contrary, males increased until the sex-ratio reached about 1.5:1 among adults resulted from larvae fed on the 3rd nymphal instar.

Ibrahim (1955) recorded that 687 individuals of *C. undecimpunctata* males and 795 were females were collected from the field, indicating a sex-ratio of about 1:1.16. Elliott *et al.* (1998) found that, the sex-ratio among *H. convergens*, *H. tridecimpunctata* and *H. parenthesis* adults were female biased, if adults of the three species were abundant at particular year and there was a shift in sex-ratio towards more males in the subsequent year.

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الملخص العربى

دراسة مقارنة للصفات البيولوجية لنوعى خنافس أبى العيد *Coccinella undecimpunctata* L. و *Hippodamia convergens* Guerin تحت الظروف المعملية

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أجريت تحت الظروف المعملية دراسة مقارنة للصفات البيولوجية شاملة مدة العمر، الكفاءة الغذائية، طول حياة الحشرة الكاملة والكفاءة التناسلية لنوعين من خنافس أبى العيد الشائعة وهما أبى العيد ١١ نقطة *Coccinella undecimpunctata* L. وأبى العيد ١٣ نقطة *Hippodamia convergens* Guerin، وذلك باستخدام مَنّ اللوبيا *Aphis craccivora* Koch. كفريسة. بلغت المدة الكلية للطور اليرقى لخنفساء *C. undecimpunctata* ١٣,٦ ± ٠,٠٨، ١٣,٠٢ ± ٠,١٢، ١١,٢ ± ٠,١٢ و ١٠,١٨ ± ٠,٠٩ يوما، مقابل ١٢,٩١ ± ٠,١٧، ١٢,٠٤ ± ٠,١٦، ١٠,٧٨ ± ٠,٢١ و ٨,٨٤ ± ٠,٢٦ يوما فى خنفساء *H. convergens*، وذلك عند تغذية اليرقات على العمر الأول، الثانى، الثالث، والرابع من حوريات المَنّ ، على التوالي. بلغت الكفاءة الإفتراسية للطور اليرقى لخنفساء *C. undecimpunctata* ١٤٤٠,٦٨ ± ١٢,١٧، ١١٤٩,٣٦ ± ٩,٦٥، ٨٠٩,٦٥ ± ٦,٦٨ و ٦٦١,١٤ ± ٤,٧٤ حورية مقابل ١١٠٧,٤٣ ± ٩,٦١، ٦٨٦,٣٣ ± ٨,٦٠، ٥٣٣,٢٠ ± ٥,٦٥ و ٣٧٠,٢٥ ± ٣,٧٩ حورية في حالة خنفساء *H. convergens* عند تغذية يرقة كل من الأعمار الأربعة على حوريات المَنّ ، على التوالي. سجلت أعلى كفاءة غذائية للحشرة الكاملة لنوعى المفترس أثناء فترة وضع البيض حيث تراوحت بين ٢٠٧-٢٦٣ حورية / حشرة / يوم. بلغ متوسط عمر الأنثى ٧٨,٠٥ ± ٢,٢٦و ٤٨,٨٠ ± ١,٦٦ يوما فى النوعين، على التوالي. وضعت الأنثى الواحدة الملقحة من النوع الأول ٨٨٠,٨٥ (٧٤٢-٩٨٣) مقابل ٧٢٩ (٥٨٩-٨٥١) بيضة في النوع الثاني، وكانت نسبة فقس البيض ٨١ و ٩٤%، على التوالي.