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Effect of Four Aphid Species on Certain Biological Characteristics and Life Table Parameters of *Chrysoperla carnea* Stephen and *Chrysopa septempunctata* Wesmael (Neuroptera: Chrysopidae) under Laboratory Conditions.

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Abstract: Effects of prey kinds on developmental times, mortality percent, consumption rate, longevity, fecundity, and life table parameters were studied in the common lacewings, *Chrysoperla canea* and *Chrysopa septempunctata* using the following aphids, *Aphis gossypii, Sitobion avenae, Rhopalosiphum maidis,* and *Aphis nerii* under laboratory conditions. The data revealed that the total developmental time from egg hatching to adult eclosion of the two chrysopids was differed significantly when reared on the four aphid species tested. Mortality percent of *Ch. canea* from egg hatching to adult emergence ranged from 6.5 per cent when fed on *A. gossypii* to 19.5 per cent on *A. nerii*, while in *Ch. septempunctata*, it varied from 7.0 per cent on *S. avenae* to 26.5 per cent on *A. nerii*. Larval stage of the two chrysopid tested were preferred *A. gossypii*, followed by *S. avenae, R. maidis* and *A. nerii*. The average number of aphid consumed per larva per day was also significantly differed. Considering the consumption rate of *Ch. septempunctata* adults, the females were consumed more than males and the highest consumption rate was obtained when reared on *A. gossypii*. Adult longevity, and fecundity of females of the two chrysopid species were affected by the prey kinds. The longest (*T*) and (*DT*) of predators was achieved by rearing on *A. nerii*. Whereas, the highest values of R_o, r_m, and e^{rm} were obtained when these predators were fed on *S. avenae*. Survivorship rate (*Lx*) and maximum oviposition rate per female per day (*Mx*) of Ch. carnea were high by rearing

Key Words: *Chrysoperla canea, Chrysopa septempunctata,* Neuroptera, aphid species, biological characteristic, life table parameters.

Introduction

The green lacewing, *Chrysoperla carnea* Stephens is one of the most beneficial and prolific predators found on cotton, corn, and other field crops in many parts of the world (Whitcomb and Bell, 1964; van den Bosch and Hagen, 1966; Abdel-Salam, 1995). It has relatively short generation times, adults lack a prey requirement for reproduction, thus, oviposition is not dependent on large population of prey (Hagen *et al.*, 1970; Tauber and Tauber, 1974), larvae have a relatively broad range of acceptable preys (New, 1975; Hydron and Wihtcomb, 1979), tolerant to many insecticides (Croft 1990, Wetzel *et al.*, 1991; Abdel-Salam, 1995) and they are amenable to mass-rearing, release, and manipulation in the field (Ridgway *et al.*, 1970; Hagen *et al.*, 1976; Tassan *et al.*, 1979; Hasegawa *et al.*, 1989; Tauber and Tauber, 1993). The role of *Ch. carnea* in controlling different aphid species on various crops has been studied by several investigators (Sundby, 1966; Scopes, 1969; Hagley, 1989). Ebert and Cartwright (1997) reported that *Ch. carnea* was able to cause an overall reduction in aphid abundance when caged on field grown cotton. Also, the effect of prey on the developmental times, mortality, consumption rates, longevity and fecundity of this predator has been observed (El-Dakroury *et al.*, 1977; Awadallah *et al.*, 1978; Afzal and Khan, 1978; Sengonca and Grooterhorst, 1985; Ghanim *et al.*, 1988; Obrycki *et al.*, 1989; Klingen *et al.*, 1996; Osman and Selman, 1996; Morris *et al.*, 1998; Shalaby *et al.*, 1998).

Also, it is widely recognized that the aphid lion, *Chrysopa septempunctata* Wesmael is considered to be a useful biological control candidate in limiting the abundance of aphids, insect eggs, coccids, and other soft bodied insects in cotton, corn, wheat, citrus and other cultivated crops (Pelov and Trenchev, 1973; El-Haidari and Aziz, 1978; Ghanim and El-Adl, 1987; Niijima, 1993; Abdel-Salam, 1995). It is strictly entomophagous in both the larval and adult stages, and is thought to exert a significant restraint on the increase of a variety of pests (Okada *et al.*, 1974, Pantaleoni and Curto, 1991; Niijima, 1993; Dai, 1995).

Life table parameters are fundamental to general biology as it to demography in an insect. Developmental times, survival, longevity and fecundity are basic data for life table analysis. Life table definitions are includes: 1) age-specific fecundity rate (Mx) is the mean number of female offspring produced per surviving female during the age interval (x), 2) survivorship rate (Lx) is the fraction of females living from birth to age (x), 3) the mean generation time (T), which estimates the average age of female laying eggs in a population that is in a stable age distribution, 4) the doubling time (DT) is the time (in days) needed for the population to double, 5) the net reproductive increase (R_o), which estimates the average number of female offspring from a birth cohort of females during their lifetime if they experienced a fixed pattern of age-specific birth and death rate, 6) intrinsic rate of increase (r_m), which is a measure of per capita instantaneous rate of change in population density expressed as female progeny per female per day, and 7) the finite rate of increase (e^{rm}), which measures the proportional change in population density from one day to the next, expressed in the same unit as the (r_m) (Hulting *et al.*, 1990; Yue and Childers, 1994).

In Egypt, a little attention has been paid on the effect of prey kinds on biological characteristics and life table parameters of the most common chrysopid predators, *Chrysoperla carnea* and *Chrysopa septempunctata*. Therefore, the purpose of this study was to investigate the influence of four aphid species on biological attributes of *Ch. carnea* and *Ch. septempunctata*, as well as testing the effect of different prey kinds on life table parameters of the two chrysopid predators.

Materials and Methods

Adults of *Chrysoperla carnea* Stephen and *Chrysopa septempunctata* Wesmael were obtained from maintained cultures in the laboratory collected previously from cotton, corn fields and citrus orchards. Adults of the two chrysopids were confined in glass chimney. Each chimney was placed on a half petri dish, and provided with a layer of moistened filter paper to provide humidity. Plant leaves were added to serve as oviposition sites and each chimney was covered by a muslin cloth. A piece of cotton wool soaked in sugar solution and the cotton aphid, Aphis gossypii Glover were provided as the adult food source inside glass chimney for *Ch. carnea* and *Ch. septempunctata,* respectively. Deposited eggs of the previous predators were found attached to the sides of chimney, plant leaves, filter paper and muslin cloth cover. When the eggs were laid, the female was put into another chimney. Deposited eggs from maintained adults were monitored daily till hatching. Neonate larvae of both chrysopid species were kept in a glass petri dish (9 cm in diameter). To prevent cannibalism, all experiments were done with individual rearing. The following aphid species: cotton aphid, *Aphis gossypii* Glover, cereal aphid, Sitobion avenae (Fabr.), corn leaf aphid, *Rhopalosiphum maidis* (Fitch) and oleander aphid, Aphis nerii Boyer de Fonscolombe were used as preys for both chrysopid species larvae and only adults of *Ch. septempunctata.* Feeding was provided daily by a fresh supply of certain prey on a piece of host plant leaf. Aphids were always offered daily as nymphs, and the additional aphids were increased gradually as the predator larvae grew. Each larva was examined daily for molting; counting the remaining aphids and introducing a fresh known number from each prey. Each predator species had 60 replications for each prey. All experiments were maintained in an incubator at 28.0±1.0°C, 75.0±5.0 RH and photoperiod of 14L:10D.

The developmental time of all stages (eggs, larvae, pupae and adult emergence) of the two chrysopid predators, mortality percent, and consumption rate of each larval instar were recorded. After adult eclosion, sex ratio was recorded. In the investigation on adults, 20 females and 20 males resulting from the previous experiment were set together. After copulation, the females were transferred separately to oviposit. The consumption rate of *Ch. septempunctata* adults only, sex ratio, pre-oviposition, oviposition, post-oviposition periods, and oviposition rate of either chrysopid species were determined.

All experimental data concerning the above characters were analyzed with one way analysis of variance (ANOVA). Comparisons of means of biological characters were made with the Duncan's Multiple Range Test (Costat Software, 1990).

To compare biotic potential for the two predators reared on certain aphid species, survivorship rate (Lx), age-specific fecundity (Mx), the mean generation time (T), the net reproductive increase (R_o), the intrinsic rate of increase (r_m), and the finite rate of increase (e^{rm}) were calculated for each of the two chrysopid predators using a BASIC computer program (Abou-Setta *et al.*, 1986) for females reared on certain aphid species. This computer program is based on Birch's method (1948) for the calculation of an animal's life table. The doubling time (DT) was calculated according to Mackauer's method (Mackauer, 1983). The life tables were prepared from data recorded daily on developmental time (egg to first egg laid), sex ratio, the number of deposited eggs, the fraction of eggs reaching maturity, and the survival of females. Interval of one day was chosen as the age classes for constructing the life table.

Results

Developmental times of immature stages:

Chrysoperla carnea: Data in Table 1 indicated that the incubation period of *Ch. carnea* eggs varied from 3.2±0.63 days to 3.9±0.87 with no significant difference among the four aphid species tested. Considering the developmental time of larval instars, there were no apparent variation during the first and second instar when larvae fed on the four aphid species; while the third instar larvae and total larval development had showed significant variation among the four aphid species. The shortest developmental time was obtained when larvae reared on *S. avenea* (10.5±1.1 days), while the longest time was recorded on *A. nerii* (18.77±2.80 days) (Table 1). Among the aphid species tested, there were significant differences between developmental time of pupal stage. The longest time was observed with *A. nerii,* while the shortest time were obtained with *S. avenea.* The total developmental time (from egg hatching to adult eclosion) was ranged from 32.07±2.3 (by rearing on *A. nerii*) to 20.2±1.6 days (by feeding on *S. avenae*) with significantly differed. Mortality percent from egg to adult ranged from 6.5 per cent (on *A. gossypii*) to 19.5 per cent (on *A. nerii*).

Chrysopa septempunctata: The ANOVA indicated that there were no statistically significant difference concerning egg incubation of *Ch. septempunctata* (Table 1). Developmental time of larval instars were significantly shorter by feeding on *S. avenae* than the other aphid species, while the longer time was addressed when larvae fed on *A. nerii.* Based on statistical analysis, the duration of pupal stage showed significant difference among the four aphid species. The total developmental time (from egg hatching to adult emergence) was significant difference between the aphid species tested. Mortality percent of this predator varied from 26.5 per cent when larvae reared on *A. nerii* to 7.0 per cent on *S. avenae.*

Consumption rate:

Chrysoperla carnea: The consumption rate of *Ch. carnea* larval instars is given in Table 2. The average number of aphids consumed during first instar larvae varied from 70.6±0.1.5 individuals of *A. gossypii* to 42.2±2.9 individuals of *A. nerii.* Consumption per cent differed between 7.98 per cent (on *A. nerii*) to 6.94 per cent (on *A. gossypii*). There were apparent difference in average number of the four aphid species consumed and consumption percent by the second instar larvae. Also, the same trend was obtained with the third instar larvae. The total consumption rate from certain aphid species by the larval stage of *Ch. carnea* showed significant difference. Concerning to the food preference for the predator larvae among aphid species tested, *A. gossypii* came first, followed by *S. avenae, R. maidis* and *A. nerii.* The average number of aphid consumed per larva per day was also significantly differed.

Chrysopa septempunctata: Data presented in Table 2 & 3 illustrate the consumption rate of both larval and adult stages of *Ch. septempunctata.* Based on ANOVA analysis, there were considerable differences among the three instars larvae concerning the average number of aphid consumed, consumption percent, total consumption, average number consumed per larva per day, and average number consumed per male and female. Larvae of this predator consumed daily an average of 80.15±5.8; 72.53±4.82; 67.2±3.44 and 33.22±2.6 individuals from *A. gossypii, S. avenae; R. maidis* and *A. nerii,* respectively.

In respect of adults, the average number of aphid individuals consumed by a female of *Ch. septempunctata* ranged from 2578.5±86.7 when fed on *A. gossypii* to 1495.8±50.6 on *A. ne* (Table 3). Data also revealed that the highest numbers of aph species consumed by males was 1859.6±30.5 individuals from *A. gossypii,* while the lowest numbers were obtained on *A. nerii* (Tab 3). As well as, females were consumed more than males.

Longevity and fecundity of adult stage:

Chrysoperla carnea: Results in Table 3 indicate that the mean ma longevity of *Ch. carnea* was significantly longer when fed on *A gossypii*, followed by *R. maidis, S. avenae* and shorter on *A. ne* Concerning the female, there were significant differences in the pr oviposition, oviposition, post-oviposition and total longevity perio of *Ch. carnea* on the aphid species tested (Table 3). Also, the aph species have a significant effect on female fecundity. The highe number of eggs were obtained when females of *Ch. carnea* fed o *A. gossypii,* followed by *R. maidis* and *S. avenae,* while the lowe numbers were achieved on *A. nerii* (Table 3).

Chrysopa septempunctata: Males longevity of *Ch. septempuncta* reared on *R. maidis* were significantly longer than males fed on *avenae, A. gossypii* and *A. nerii,* respectively. Pre-oviposition peri of females ranged from 15.6±0.90 days (on *A. nerii*) to 9.2±0. days (on *S. avenae*).The ANOVA indicated that prey species ha

Table 1: Duration of the developmental stages of two chrysopid predators reared on certain aphid species under laboratory conditions.

Aphid species	Incubation period (Mean ± SD)	Larval instars duration (Mean ± SD)* 1st	2nd	3rd	Total	Pupal stage (Mean ± SD)	Total duration (from egg to adult) (Mean ± SD)	Mortality %
				Ch. carnea				
A. Gossypii	3.8a ±0.38	2.3a ±0.15	2.9a ±0.14	8.3ab ±0.96	13.5b ±1.50	7.5b ±0.30	24.8b ±1.9	6.5
S. Avenae	3.2a ±0.63	2.10a ±0.13	2.5a ±0.12	5.9b ±0.70	10.5c ±1.10	6.5b ±0.15	20.2c ±1.6	9.5
R. Maidis	3.5a ±0.28	2.20a ±0.13	2.7a ±0.13	7.2a ±0.98	12.1bc ±1.30	7.2b ±0.35	22.8bc ±1.78	10.5
A.nerii	3.9a ±0.87	3.7a ±0.19	4.37a ±0.36	10.70a ±1.80	18.77a ±2.80	9.4a ±0.29	32.07 ±2.3	19.5
				Ch. Septempuncata				
A. Gossypii	3.2a ±0.63	4.20ab ±0.63	5.76ab ±0.86	9.80ab ±1.20	19.76b ±3.70	10.8ab ±0.33	33.76b ±2.5	11.0
S. Avenae	2.9a ±0.22	2.60b ±0.19	3.40b ±0.22	6.5c ±0.40	12.50d ±2.1	9.5b ±0.28	24.79d ±1.9	7.0
R. Maidis	2.9a ±0.22	3.40ab ±0.48	4.23ab ±0.90	7.9bc ±0.86	15.53c ±1.92	10.2ab ±0.52	28.63c ±1.6	9.5
A.nerii	3.5a ±0.47	5.76a ±0.58	6.89a ±0.72	11.60a ±0.14	24.25a ±4.2	11.9a ±0.87	39.65a ±2.3	26.5

Table 2: Mean numers consumed from different from different aphid species during larval instars of two chrysopid predators under laboratory condition.

Aphid species	Average* no of aphid individuals consumed (±SD) and its percent to the total consumption: 1st No.	1st %	2nd No.	2nd %	3rd No.	3rd %	Total	Average no Consumed /larva /day (±SD)
				Ch. carnea				
A. Gossypii	70.6a ±1.5	6.94	138.5a ±9.7	13.61	805.0a ±16.5	79.45	1013.6a ±42.5	75.08a ±8.50
S. Avenae	56.9b ±1.90	7.74	105.2b ±6.8	14.32	572.4b ±21.6	77.94	734.5b ±26.8	69.95b ±5.39
R. Maidis	55.1b ±2.20	7.68	101.0c ±5.2	14.09	560.8c ±16.2	78.23	716.9c ±30.58	59.25c ±7.26
A.nerii	42.2c ±2.9	7.98	84.3d ±6.8	15.95	402.0d ±18.5	76.06	528.5d ±33.4	28.15d ±6.40
				Ch. Septempuncata				
A. Gossypii	130.5a ±3.6	8.24	450.6a ±26.2	28.51	998.7a ±38.26	63.25	1579.8a ±46.76	80.15a ±5.8
S. Avenae	89.6c ±2.5	9.88	166.8d ±6.8	18.39	650.3c ±26.5	71.73	906.7c ±35.2	72.53 ±4.82
R. Maidis	101.7b ±9.90	9.74	201.6c ±17.5	19.32	740.6b ±35.7	70.94	1043.9b ±40.5	67.2c ±3.44
A.nerii	55.70d ±8.2	6.92	213.6b ±20.2	26.51	536.4d ±30.4	66.57	805.7d ±35.2	33.22d ±2.6

no significant effects on the duration of oviposition period (Table 3). The post-oviposition period ranged from 9.16±0.48 days when females reared on *A. gossypii* to 5.90±0.46 days on *A. nerii*. The total longevity of *Ch. septempunctata* females varied from 39.67±3.70 days to 34.6±2.50 days and appear to influenced by aphid species. When *S. avenae* individuals were offered for females, higher oviposition rate was obtained rather than the other three aphid species tested.

Life table parameters:

Chrysoperla carnea: The sex ratio of *Ch. carnea* was 1:1 and not significantly influenced by the prey species. The value of mean generation time (T) was longest (50.01 days) when females fed on *A. nerii*, while it was shortest (34.27 days) when *S. avenae* was provided. The population of *Ch. carnea* could be doubled every 77.88, 5.52, 5.50 and 4.79 days when females fed on *A. nerii, R. maidis, A. gossypii* and *S. avenae*, respectively. The shortest time for doubling population (DT) was achieved when this predator reared on *S. avenae*. Whereas, the longest (DT) was recorded with the feeding on *A. nerii*. The highest net reproductive rate (R_o=219.81) was occurred when females fed on A. gossypii, while the lowest value (R_o =86.93) was obtained with *A. nerii* (Table 4). The intrinsic rate of increase (r_m) was highest when females reared with *S. avenae*, while the lowest (r_m) was obtained with *A. nerii*. Rearing on *A. nerii* resulted lower value of the finite rate of increase (e^{rm}), while with *S. avenae*, the maximum (e^{rm}) value was obtained (Table 4). From data illustrated in Fig. 1, it could be noted that the survivorship (Lx) for female age intervals was high (0.935) on *A.*

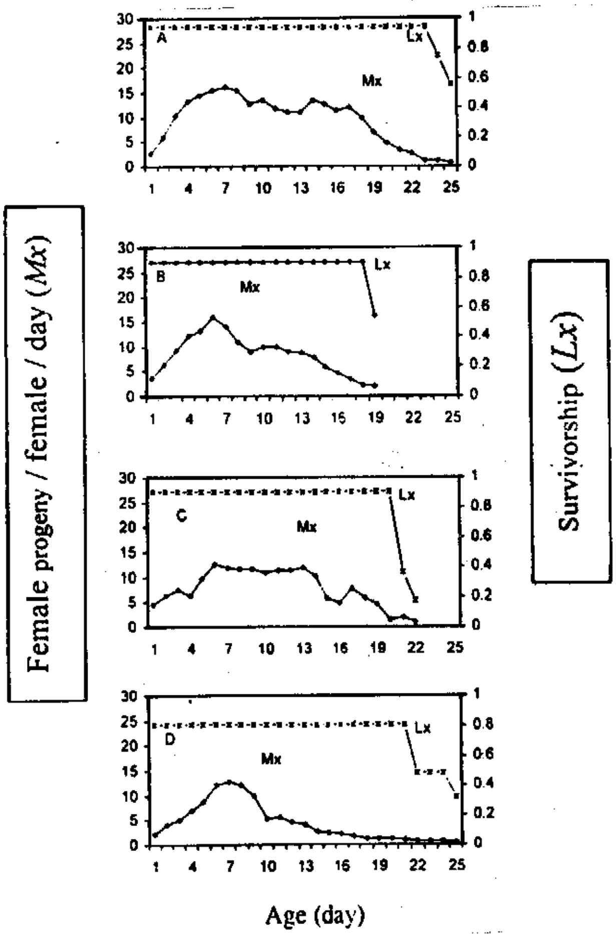

Fig. 1: Age-specific fecundity (Mx) and survivorship (Lx) of *Ch. carnea* rearing on four aphid species. (A) *A. gossypii*, (B) *S. avenae*, (C) *R. maidis*, (D) *A. nerii*).

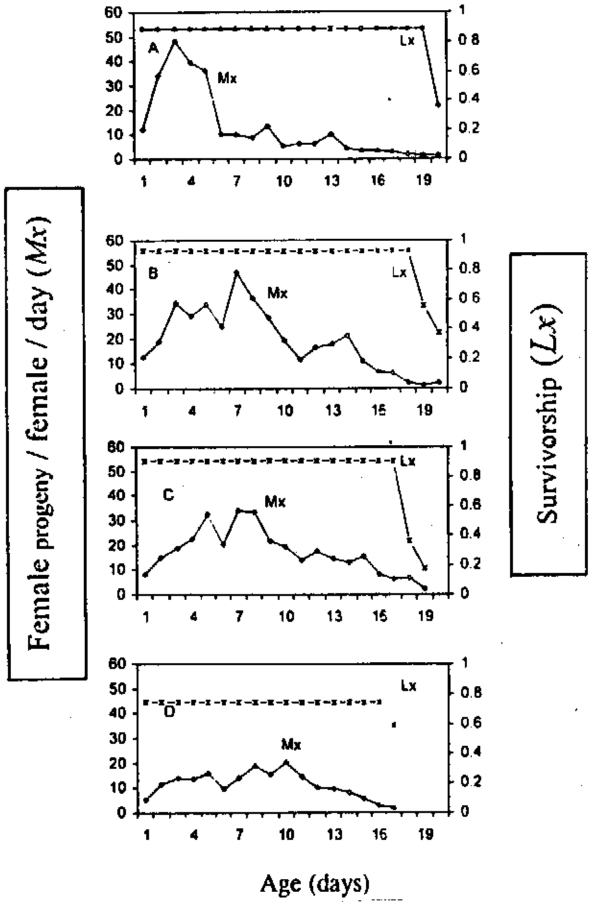

Fig. 2: Age-specific fecundity (Mx) and survivorship (Lx) of *Ch* *septempunctata* rearing on four aphid species. (A) *A* *gossypii*, (B) *S. avenae*, (C) *R. maidis*, (D) *A. nerii)*.

Table 3: Longevity, fecundity, and consumption rate of two chrysopid perdators feeding on different aphid species under laboratory conditio

Aphid species	Sex	No.	Longevity (mean ± SD)*				No. of eggs/ Female (mean ± SD)	No of aphids Consumed /adult (mean ± SD)
			Preovipos- Ition	Ovipo- sition	Postovipos- ition	Total longe- vity		
					Ch.carnea			
A. gossypii	M	20	-	-	-	24.6A ± 4.2	-	-
	F	20	9.46 ± ab0.73	24.6 ± 0.39	8.40a ± 0.72	42.46a ± 6.5	480.2a ± 14.2	-
S. avenae	M	20	-	-	-	19.70BC ± 3.40	-	-
	F	20	7.29b ± 0.60	18.6b ± 0.74	6.9ab ± 0.26	32.79c ± 2.4	320.26c ± 10.90	-
R. maidia	M	20	-	-	-	21.60B ± 4.50	-	-
	F	20	8.9ab ± 0.84	20.50b ± 0.63	7.20ab ± 0.34	36.6b ± 3.6	336.44 ± 12.50	-
A. nerii	M	20	-	-	-	17.36 ± 3.50	-	-
	F	20	10.72a ± 0.88	26.15a ± 1.42	5.73b ± 0.68	42.6a ± 5.9	215.70 ± 9.6	-
					Ch. Septempunctata			
A. gossypii	M	20	-	-	-	25.6BC ± 1.4	-	1859.6A ± 30.
	F	20	11.18b ± 0.97	19.33a ± 0.88	9.16a ± 0.48	39.67a ± 3.70	522.46c ± 20.22	2578.5a ± 86.
S. avenae	M	20	-	-	-	26.60B ± 1.50	-	881.96C ± 26.
	F	20	9.2b ± 0.30	17.9a ± 0.58	7.5ab ± 0.4	34.6b ± 2.50	750.60a ± 30.50	1504.98c ± 62
R. maidia	M	20	-	-	-	29.46A ± 2.40	-	1236.7B ± 28.
	F	20	9.82b ± 0.66	18.56a ± 0.89	8.57ab ± 0.80	36.95ab ± 3.0	633.90b ± 18.30	2069.97b ± 75
A. nerii	M	20	-	-	-	23.0C ± 4.56	-	810.5D ± 22.7
	F	20	15.60a ± 0.96	16.83a ± 0.74	5.90b ± 0.46	83.33a ± 4.5	380.73d ± 22.9	1495.8d ± 50.

Table 4: Life table parameters of two chrysopid predators fed on certain aphid species under laboratory conditions.

Aphid species	Initial No of Female	Mean generation time (T) (in days)	Doubling time (DT) (in days)	Net reproductive rate (Ro)	Intrinsic rate of increase (r_m)	Finite rate of increase (e^m)
			Ch. carnea			
A. gossypii	20	42.82	5.50	219.81	0.1259	1.1342
S. avenae	20	34.27	4.79	142.62	0.1447	1.1557
R. maidia	20	40.99	5.52	151.61	0.1255	1.1337
A. nerii	20	50.01	77.88	86.93	0.0089	1.0933
			Ch. septempunctata			
A. gossypii	20	49.42	6.29	231.31	0.1101	1.1164
S. avenae	20	40.26	4.75	354.51	0.1457	1.1569
R. maidia	20	45.18	5.53	287.33	0.1252	1.1334
A. nerii	20	62.14	87.74	140.97	0.00979	1.0828

gossypii which means most of eggs developed to maturity and death happened gradually after an extended ovipositional period, while on *A. nerii*, the value of (Lx) was low (0.805). Maximum oviposition rate per female per day (Mx) was 16.3 when females fed on *A. gossypii* on 7th day and 16.0 on 6th day with *S. avenae*, while the minimum oviposition was achieved with *R. maidis* on 6th day (Fig. 1). Oviposition was continued until the last days of oviposition period.

Chrysopa septempunctata: Also, the sex ratio of *Ch. septempunctata* was not affected by the prey species tested. The value of mean generation time (T) was ranged from 62.14 to 40.2 days when females of this predator reared on the four species (Table 4). The shortest generation time was obtained by rearing on *S. avenae*, while with *A. nerii*, the longest (T) was achieved. The doubling time (DT) differed according to aphid species. The highest value of (DT) (87.74 days) was obtained by rearing on *A. nerii* and the lowest one (4.75 days) was achieved on *S. avenae*. The highest values of net reproductive rate (R_0=354.51), the intrinsic rate of increase (r_m=0.1457), and the finite rate of increase (e^{rm}=1.1569) were recorded when females fed on *S. avenae*, while the lowest values (R_0=140.97), (r_m=0.0079), and (e^{rm}=1.0828) were obtained when females reared on A. nerii (Table 4). As appears from Fig. 2 the survivorship (Lx) for female age intervals was low (0.735) on *A. nerii*, indicating the decline in the probability of female survival on this prey, while on *S. avenae*, the value of (Lx) was high (0.93). Maximum daily oviposition per female (Mx) was 48.30 on 3rd day when females of *Ch. septempunctata* fed on *A. gossypii* as a prey followed by *S. avenae* on 7th day, *R. maidis* on 7th day, while with *A. nerii*, the minimum (Mx) value was recorded on 10th day (Fig. 2).

Discussion

Our finding illustrate that, there were no apparent difference concerning the incubation period of *Ch. carnea* and *Ch. septempunctata* eggs resulted from rearing on the four aphid species. Similar results were found by El-Dakroury *et al.* (1977) who reported that the incubation period of *Ch. carnea* averaged 3.2 days when *Ch. carnea* fed on eggs and larvae of Heliothis amerigera (HB.) at 27-30°C. Also, Awadallah *et al.* (1978) found that *Ch. carnea* eggs were hatched after 3.11, 2.97, 3.2 and 3.15 days when reared on Thrips tabaci Lind. nymphs, Gynaikothrips ficorum (Marchal) nymphs, Spodoptera littoralis (Boisd.) egg-masses and Aphis punicae Pass. at 28°C. As well as, Abdel-Galil *et al.* (1991) mentioned that this period was 3.7 and 3.1 days when *Ch. carnea* fed on *A. gossypii* at 26 and 30°C, respectively.

Results of *Ch. carnea* in the current study revealed that the developmental times of larval and pupal stages were shorter (10.5 and 6.5 days) when reared on *S. avenae* and longer on *A. nerii* (18.77 and 9.4 days, successively). Similarly, the same trend was observed with *Ch. septempunctata*. The total duration period (from egg hatching to adult eclosion) was statistically differed when both chrysopid predators reared on the four aphid species tested. Similar observations showed that larval developmental time of *Ch. carnea* took 10.2 and 15.8 days on *H. armigera* eggs and larvae (El-Dakroury *et al.*, 1977), 11.32 days on *A. punicae* (Awadallah *et al.*, 1978), 8.8 days on Sitotroga cerealella Oliv. (Hassan and Hagen 1978), 10.9 days on pupae of *Bemisia tabaci* Genn. (Ghanim and El-Adl, 1988), 14.1 days on *R. maidis* (Obrycki *et al.*, 1989), 10.2 days on Ephestia kuehniella Zell. (Letardi and Caffarelli, 1989), 9.6 and 8.9 days on *A. gossypii* at 26 and 30°C, respectively (Abdel-Galil *et al.*, 1991), 10.2 and 13.1 days on *Mamestra brassicae* (L.) eggs and larvae (Klingen *et al.*, 1996).

The pupal stage lasted 6.7 and 7.9 days on *H. armigera* eggs and larvae (El-Dakroury *et al.*, 1977), 8.3 days on *A. punicae* (Awadallah *et al.*, 1978), 8.7 days on *S. cerealella* (Hassan and Hagen, 1978).

Concerning *Ch. septempunctata*, developmental time of larval stage averaged 10.4, 12.3, 10.8 and 13.8 days on *Aphis craccivora* Koch, nymphs of *G. ficorum*, eggs and newly hatched larvae of *S. littoralis* (Ghanim and El-Adl, 1987) and 23.8 days on the aphid, Lanchnus tropicalis (Niijima, 1993).

Also, the total developmental time of *Ch. carnea* from egg to adult emergence was found to closely match with results addressed by El-Dakroury *et al.* (1977) (19.8 and 26.7 days on *H. armigera* eggs and larvae), 22.82 days on *A. punicae* (Awadallah *et al.*, 1978), 25.5 days on *A. gossypii* (Afzal and Khan, 1978), 30.9 days on *R. maidis* (Obrycki *et al.*, 1989), 20.3 days on *E. kuehniella* (Letardi and Caffarelli, 1989), 23.32 and 19.70 days on *A. gossypii* at 26 and 30°C, respectively (Abdel-Galil *et al.*, 1991), 20.15 days on *A. gossypii* (Balasubramani and Swamiappan, 1994), 21.9 and 27.4 days on *M. brassicae* eggs and larvae (Klingen *et al.*, 1996).

The current results demonstrated that mortality percent varied significantly on the aphid species tested. The lower percent (6.5 and 7.0%) was obtained for *Ch. carnea* and *Ch. septempunctata* by feeding on *A. gossypii* and *S. avenae*, respectively, while it was higher on *A. nerii* (19.5 and 26.5%) for the two predators (Table 1). This figure coincides with that of 27.0 per cent on *R. maidis* (Obrycki *et al.*, 1989), 9.7 and 15.0 per cent on *M. brassicae* eggs and larvae (Kligen *et al.*, 1996).

As shown by our results, there were significant difference concerning the total consumption rate of larval stage when reared on the four aphid species tested. The maximum rate value was recorded with *A. gossypii* for both chrysopid larvae. The same trend was also observed concerning the average number of aphids consumed per larva per day. Over than 79.45 per cent from *A. gossypii* and 71.73 per cent from *S. avenae* were consumed by the third instar larvae of *Ch. carnea* and *Ch. septempunctata*, respectively. This finding is in complete agreement with those addressed by Scopes (1969). As well as, El-Dakroury *et al.* (1977) mentioned that 63 and 85 per cent of eggs and larvae of *H. armigera* killed by the third instar larvae. Sengonca and Grooterhorst (1985) found that 86.23 and 85.20 per cent from eggs of *Barathra brassicae* L. and *S. littoralis* consumed by the third larvae. Also, Obrycki *et al.* (1989) mentioned that consumption percentage of third instar larvae of *Ch. carnea* was 85, 73 and 84 per cent when fed on *Agrotis ipsilon* Huf. eggs, newly hatched larvae and *Ostrinia* *nubilalis* Hubn. eggs, respectively. Klingen *et al.* (1996) observed that about 85 per cent of the total eggs and larvae of *M. brassicae* were eaten by the third instar larvae of *Ch. carnea.* Our experiments indicate that *A. gossypii* might be the most preferable prey over the other aphid species tested. The consumption rate of *Ch. septempunctata* males and females was also affected significantly by aphid species. The maximum consumption rate (1859.6 and 2578.5) was recorded with feeding on *A. gossypii* for males and females, respectively. These results are supported by those of Ghanim and El-Adl (1987).

Adults longevity and fecundity of *Ch. carnea* and *Ch. septempunctata* was significantly differed when reared on the four aphids tested (Table 3). Similar results were found by Ghanim *et al.* (1987) who reported that the total longevity of *Ch. carnea* females was 37.4 days on *B. tabaci* nymphs, and total number of eggs were 327.6. Shalaby *et al.* (1998) mentioned the the longest oviposition period (24 days) and highest eggs productivity (243.37 eggs/female) were obtained by larval feeding of *Ch. carnea* on Pectiophora gossypiella (Saunders) eggs, while the lowest values (11.5 days and only 33 eggs/female) were recorded by feeding on a mixture of 1 eggs: 3 1st instar larvae of *P. gossypiella.* Also, Ghanim and El-Adl (1987) recorded that the total longevity and total number of eggs of *Ch. septempunctata* were 24.0 days and 313.2 eggs on *A. craccivora,* while the longevity of males were 19.8 days. Results of this study also indicated that the sex ratio of both chrysopids was not affected by rearing on aphid species. These agree with the findings of El-Dakroury *et al.* (1977) who reported that the sex ratio was 1:1 on eggs and larvae of *H. armigera.* The intrinsic rate of increase (r_m) is a perfect indicator of the prey species at which the growth of population is most favorable because it reflects the overall effects of preys on development, reproduction, and survival characteristics of a population (Tsai and Wang, 1999). The values of mean generation time (T), doubling time (DT), net reproductive rate (R_o), intrinsic rate of increase (r_m) and finite rate of increase (e^{rm}) were affected greatly by rearing of the two chrysopid species on the four aphids examined. The higher values of R_o, r_m and e^{rm} and shortest (T), and (DT), were achieved when reared on *S. avenae* and *A. gossypii,* while the lowest R_o, r_m and e^{rm} and longest (T), and (DT) were recorded on *A. nerii.* The reduction in (r_m) when *Ch. carnea* and *Ch. septempunctata* reared on A. nerii could be attributed to longer developmental times of immature stages and longer longevity; which resulted in a considerably longer mean generation time (Tsai and Wang, 1999).

The survivorship (Lx) for female age intervals was high on *A. gossypii* and *S. avenae* for the two predators, as well as the maximum oviposition rate per female per day (Mx) was 16.3 and 48.3 for *Ch. carnea* and *Ch. septempunctata,* respectively on *A. gossypii.* There are no published data on the effect of prey kinds on life table parameters for *Ch. carnea* and *Ch. septempunctata* for comparisons. Except, Kubota and Shiga (1995) reported that (r_m) value of *Ch. carnea* was 0.12 when reared on eggs of *Tribolium castaneum* (Herbst). This value is less than (r_m) values calculated in our study which was varied from 0.1447 (on *S. avenae*) to 0.0089 (on *A. nerii*). However, a few investigations on other chrysopid species considering life table parameters have been studied. Canard (1970) reported that (r_m) value was 0.0015-0.022 for Chrysopa perla L. Also, Lee and Shih (1982) found that (r_m) value was 0.096 for Chrysopa boninensis Okamoto. As well as, Lopez-Arroyo *et al.* (1999) recorded that (T) values for three species from chrysopids in genus Ceraeochrysa namely: *C. cincta* (Schneider), *C. cubana* (Hagen), and *C. smithi* (Navos) were 43.6, 70.8 and 54.8 days, respectively, while (r_m) values were 0.081, 0.063 and 0.084, successively.

Our results declared clearly that the aphid species differed in their degree of suitability for the two predators studied. The suitability of prey resulting in an increasing consumption rate, shorted developmental times, greater survival rate, and higher fecundity females (Holling, 1961; Slansky and Rodriguez,1987; Crawley, 1992). Also, the suitable prey must provide all nutritionally important factors such as proteins, carbohydrates, lipids, vitamins and minerals in balanced proportion and concentration to meet predators metabolic requirements, and mobility of prey also play large role in prey suitability (House, 1966; 1977).

Consequently, it could be concluded from the current study that S. *avenae,* and *A. gossypii* were the most suitable preys followed by *R. maidis.* This suggests that the two lacewings are suitable for mass- rearing only on *S. avenae, A. gossypii,* and *R. maidis,* and could be used as a biological control agents against the same species of aphids in several economic crops such as cotton, wheat, corn, and vegetables. Also, these results could provide a means of predicting the biological characteristics of all stages of these predators when released in the fields. Further investigations are needed to compare between the biological characteristics and life table parameters which obtained from laboratory studies with that of semi-field and field experiments in field crops or greenhouses.

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