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COMPARATIVE LIFE TABLE STATISTICS OF *Exochomus Nigromaculatus* (GOEZE) REARED ON THE PINK MEALYBUG, *Maconellicoccus Hirsutus* (GREEN), FED ON FOUR HOST PLANTS.

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ABSTRACT

Studies on the life and fertility tables of the coccinellid predator, *Exochomus nigromaculatus* (Gose). were conducted to estimate some of its biological aspects on four different host plants (hibiscus, Sprouted potatoes, Grape and Japanese pumpkins *Cucurbita mostchata* Duchesne) infested with hibiscus mealybug, *Maconellicoccus hirsutus* (Green).

The stage duration, survival rate, the net reproductive rate and the intrinsic rate of natural increase were examined. The developmental periods were significantly affected by host plant. The mean duration of the larval stage on Grape, Japanese pumpkins, hibiscus and Sprouted potatoes, were 14.60±0.94, 14.78±1.11, 15.05±0.71 and 17.14±0.94 days, respectively. The total developmental timeof immature stages lasted 29.11±1.1, 29.89±1.13, 30.70±1.03 and 32.27±1.2 days on hibiscus, pumpkin, grape and potatoes, respectively.

The stage specific survival of life table data indicated that the mortality factor operated mainly during larval stage. The highest larval survival of 76.63±5.77% was recorded on potatoes followed by 68.9 ± 1.91% on hibiscus and 67.8±1.91 ± 5.1 % on grape; while the least (66.7±10 %) occurred on pumpkin.

The fertility of *E. nigromaculatus* females was relatively high on hibiscus followed by potatoes, pumpkin and grape. The net reproductive rate was 30.37 ± 3.85, 29.18 ± 7.7, 28.94 ± 4.73 and 25.27±6.3 females/ female, respectively, while, the intrinsic rate of increase (r_m) was 0.081 ± 0.02, 0.076 ± 0.01, 0.071± 0.01 and 0.068 ± 0.01 females/ female/ day, on pumpkin, hibiscus, grape and potatoes, respectively. The generation time lasted 49.4±6.6, 45.9±4.1, 45.6±4.0, and 43.42 ± 9.9 days, respectively.

INTRODUCTION

Hibiscus mealybug, *Maconellicoccus hirsutus* (Green) one of the most serious pests on several host plants, at outbreak densities can be quite extensive actually destroying hibiscus and ornamental landscape planting (Meyerdik, 1999 and Kairo *et al*., 2000). According to Pollard (1995) *M. hirsutus* attacks a wide variety of host plants. It attacks grapes (Mani *et al.*, 1987), guava (Mani and Krishnamoorthy, 2001) and it was recorded on the roots of some date trees (Elwan, 2000).

Insecticides do not provide an effective control against mealybugs (Krishnamoorthy and Mani, 1994). In the last few years, the Ministry of Agriculture aims to minimize the use of insecticides in integrated pest management programs. To maintain the natural balance, it must be raising the use of native or imported natural enemies. In order to achieve a

successful biological control in any area, searching for the well established and most efficient biological agents should be involved Abd El-Kareim (2002).

Coccinellids are potentially important predatory insect group found throughout the world on many economic crops. Some species may have a significant role in biological control of aphid species, whiteflies, and other soft-bodied insects. *E. nigromaculatus* (Coleoptera: Coccinellidae) is an important indigenous predator of mealybugs (Homoptera: Pseudococcidae) (Ru,-B and Mitsipa, 2002).

The intrinsic rate of natural increase (r_m) which is regarded as the best available single description of the population growth of a species under given conditions (Southwood and Henderson, 2000). It can be used for predator's selection and it is suitable for evaluation of the mass rearing quality of biological control agents. It can be determined by its developmental time and reproduction rate. It has been used to compare a species under different environmental conditions and as an index of population rate response to selected preys (Hulting *et al*., 1990.; Roy *et al*., 2003; Lanzoni *et al*., 2004).

Therefore, the objective of this study was to assess some biological properties of *E. nigromaculatus* on four host plants to serve as a basis for the use of this predatory coccinellid in a biological control program. Developmental time and mortality of different immature stages, longevity and fecundity were determined. Life tables were constructed using these data.

MATERIALS AND METHODS

Insect sources:

The coccinellid predator, *Exochomus nigromaculatus* (Goeze) adults were collected from hibiscus, *Hibiscus rosa-sinensis* L. at the Experimental Research Station, Faculty of Agriculture, Mansoura University.

To have an initial population of *E. nigromaculatus* eggs homogenous in age, pairs of male and female adults were introduced to plastic screen-cages (15 cm diameter x 25 cm in length and 10 cm height) and provided with preys (the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green)). The eggs of *E. nigromaculatus* were collected daily, and monitored until hatching .To avoid cannibalism, hatched larvae were reared individually in Petri dishes (9 cm in diameter) under laboratory conditions. A piece of filter paper was placed on the bottom of each dish to provide a walking surface for the larvae.

Construction of life table for *E. nigromaculatus* on different host plants:

To estimate the influence of host plant on the development and survival rate *E. nigromaculatus*. thirty larvae from the predator were reared on *M. hirsutus* collected from four different host plants (hibiscus *Hibiscus rosa-sinensis* L., Sprouted potatoes *Solanum tuberosum* L., Grape and Japanese pumpkins). Each larva was considered as a replicate. The developmental time and survival rate of immature stages, from eggs to adult eclosion were recorded.

Construction of fertility table for *E. nigromaculatus* on different host plants:

To construct age–specific fertility table, ten pairs of newly emerged adults (males and females) of the predator / host plant were introduced in Petri dishes (one pair / dish) and provided daily with preys reared on the previously mentioned host plants until death. The longevity of females (pre-oviposition, ovipostion and post-ovipostion, periods) was estimated. Also, the females were daily observed until their death and the daily number of eggs laid per female was recorded.

To estimate the stage-specific survival (l_X) and the intrinsic rate of natural increase (r_m), life and age-specific fecundity tables were constructed as follow:

Life table was constructed with the following columns:

x : The pivotal age for the age class in days.

l_x : The number of survivals at the beginning of age class x.

d_x : The number of deaths during the age interval x.

Age specific fertility table was constructed with the following columns:

x : Actual female age (time from eggs).

m_X : The number of living females born per female in each age.

L_X : Represented the fraction surviving of females of an initial population of one.

The parameters, net reproductive rate (Ro), mean generation time (T) and the intrinsic rate of increase (r_m) were calculated according to Southwood (1978) as follow :

$$Ro = \Sigma L_X m_X$$

$$T = \Sigma x (L_X m_X) / Ro$$

$$r_m = \ln (Ro) / T$$

Data analysis:

Data of developmental times of immature stages, pre-oviposition, oviposition, and post-oviposition periods, total longevity of females, fecundity, fecundity rate, and the male longevity of *E. nigromaculatus* reared on *M. hursutus* were subjected for one way analysis of variance (ANOVA), and the means were separated using Duncan's Multiple Range Test (CoHort Software, 2004).

RESULTS AND DISCUSSION

Developmental times of immature stages

The result in table (1), showed that when the immature stages of *E. nigromaculatus* reared on *M. hursutus* which was fed on different host plants, the shortest period in the first generation was on hibiscus plant (15.05±0.71 &29.11±1.10 days) for total larval and total developmental time. Meanwhile, the potatoes recorded the highest period (17.14±0.94 and 32.27±1.20 days) for the total larval and the total developmental time. Staticall analysis shows significant variation in four larval instars, pupa and total developmental time in the first generation.

Table (1): Developmental time (mean±SEM) in days of immature stages of *E. nigromaculatus* reared on pink mealybug on four host plants at laboratory conditions in three generations.

Host plant	Generation	Egg	Larva	Pupa	Total developmental time
Hibiscus	G1	6.67±0.61 b	15.05±0.71 b	7.58±0.51 b	29.11±1.10 b
	G2	6.53±0.51 a	13.89±1.10 b	5.26±0.45 h	26.21±1.32 ab
	G3	6.0±0.78b	15.05±0.89b	7.26±0.64b	28.75±1.21c
	mean	6.43	14.66	6.7	28.02
Pumpkin	G1	7.40±0.62 a	14.78±1.11 b	7.67±0.49 b	29.89±1.13 b
	G2	5.47±0.57 b	14.57±1.31 a	6.48±0.51 a	26.57±1.53 a
	G3	6.27±0.45b	15.25±1.7ab	5.40±0.75c	27.00±1.84d
	mean	6.38	14.87	6.19	27.82
Grape	G1	7.43±0.57 a	14.60±0.94 b	8.60±0.50 a	30.70±1.03 b
	G2	5.67±0.76 b	13.53±1.02 b	5.95±0.78 c	25.42±1.12 b
	G3	7.57±0.50b	14.58±1.02b	8.58±0.51a	30.74±0.81b
	mean	6.89	14.24	7.71	28.95
Potatos	G1	6.67±0.61 b	17.14±0.94 a	8.59±0.59 a	32.27±1.20 a
	G2	4.33±0.48 c	14.76±0.93 a	7.08±.69 b	26.16±1.43 a
	G3	7.30±0.75a	15.86±1.42a	8.90±0.70a	32.10±1.70a
	mean	6.1	15.92	8.19	30.18
LSD	G1	0.29	0.59	0.35	1.26
	G2	0.30	0.69	0.44	1.49
	G3	0.33	0.86	0.43	1.38

In the second generation the predator *E. nigromaculatus* recorded significant differences between grape and three other host plants. The shortage time spend 25.42±1.12 days in total developmental time when the predator was reared on grape. There were no significant differences between pumpkins and potatoes in total developmental time (Table 1).

In the third generation for rearing of *E. nigromaculatus* on pink mealybug there was significant values between the four host plants in the total of developmental time. As shown in table (3) the shortest period for immature stages (egg, larvae and pupae) was 27.00±1.84 days when the host pumpkin. Mean while, the longest period was 32.10±1.70 days on potatoes.

Survival percentage:

The total larval survival was the highest percentage (83.3%) on potatoes in the second generation. Meanwhile, pupal stage recorded 100% survival in the first and second generations on potatoes (Table 2).

Life table parameters

Data presented in Table (3), illustrate the life table parameters of *E. nigromaculatus* females when reared on four host pants in three generations. The mean generation time (T) was 48.07, 40.98 and 47.86 days, respectively when reared on hibiscus in three successive generations. On pumpkin the mean generation time was 52.74, 33.03 and 44.49 in the first, second and third generation, respectively. On the grape the highest (T) was 48.65 days in the first generation and the lowest was 41.16 day in the second generation.

Table (2): Survival percentages of *E. nigromaculatus* immature stages reared on pink mealybug which fed on (hibiscus, pumpkin, grape and potatoes) on four host plants under laboratory conditions.

Host plant	Season	Larval instar					Pupal stage
		1st	2nd	3rd	4th	Total	
Hibiscus	G1	90.0	88.9	91.7	95.5	66.7	90.0
	G2	90.0	92.6	92.0	91.3	70.0	95.2
	G3	90.0	88.9	91.7	95.5	70.0	95.2
Pumpkin	G1	90.0	85.2	87.0	90.0	56.7	94.4
	G2	96.3	90.0	88.2	96.0	76.7	95.8
	G3	90.0	92.6	92.0	95.7	66.7	90.9
Grape	G1	90.0	88.9	91.7	95.5	70.0	95.2
	G2	86.7	92.3	87.5	95.2	66.7	95.0
	G3	80.0	91.7	95.5	95.2	66.7	95.0
Potatos	G1	86.7	96.2	92.0	95.7	73.3	100.0
	G2	93.3	96.4	96.3	96.2	83.3	100.0
	G3	86.7	92.3	95.8	95.7	73.3	95.5

The net reproduction rate (R_o), representing the total female births was highest in the second generation (35.45) on hibiscus. This meant that the population of this predator would be able to multiply 35.45 times when fed on *M. hursutus* which fed on hibiscus at the end of each generation.

While the highest (Ro) in case of pumpkin 34.15 in the second generation. The highest (Ro) 37.94 in the first generation when *E. nigromaculatus* reared on *M. hursutis* which fed on potatoes.

The value of the intrinsic rate of increase (r_m) was always the highest in the second generation in all the four host plants recorded (0.0871, 0.1069, 0.0835 and 0.0775) respectively for hibiscus, pumpkin, grape and potatose (Table 3).

Table (3): Life table parameters of *E.nigromaculatus* females when reared on pink mealybug on four host plants at laboratory conditions.

Host plant	Generation	R_O	R_M	T
Hibiscus	G1	30.37	0.0710	48.07
	G2	35.45	0.0871	40.98
	G3	27.89	0.0695	47.86
	mean	31.24	0.0759	45.64
Pumpkin	G1	27.57	0.0629	52.74
	G2	34.15	0.1069	33.03
	G3	24.92	0.0723	44.49
	mean	28.88	0.0807	43.42
Grape	G1	26.15	0.0671	48.65
	G2	31.09	0.0835	41.16
	G3	18.59	0.0610	47.87
	mean	25.27	0.0705	45.89
Potatos	G1	37.94	0.0661	54.97
	G2	26.01	0.0775	42.05
	G3	23.58	0.0618	51.15
	Mean	29.18	0.0685	48.30

DISCUSSION

In the present study, the coccinellid predator, *E. nigromaculatus* exhibited different biological parameter when reared on various host plants infested with the pink mealybug. The duration of immature stages of *E. nigromaculatus* as well as survival percentages of all developmental stages (larvae and pupae)were significantly affected by the host plant. Also, the demographic statistics of the ladybird *E. flaviventris* were investigated under laboratory conditions on the cassava mealybug, *P. manihoti,* reared on four host plants with different levels of antibiotic resistance to the mealybug: two cassava cultivars (Incoza and Zanaga), one hybrid of *Manihot esculenta* x *M. glaziovii* (Faux-Caoutchouc, FC) and the water weed (*Talinum triangulare*). Pre-imaginal mortality, net reproductive rate, intrinsic rate of increase and generation time of *E. flaviventris* were strongly affected by the host plant (Ru,-B and Mitsipa,2002).

Giles *et al.* (2002), studied the interactions among host plants (*Medicago sativa* L., cv. `OKO8' and *Vicia faba* L., cv. `Windsor'), aphid prey (*Acyrthosiphon pisum* Harris, Homoptera: Aphididae), and *Coccinella septempunctata* L. (Coleoptera: Coccinellidae). Who found that host plant effects achieved at the third trophic level .

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تأثير العائل النباتى على جداول الحياه والخصوبة للمفترس *Exochomus nigromaculatus*. (Green)

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بدراسة جداول الحياه والخصوبة للمفترس *Exochomus nigromaculatus*. عندما ربى على أربع عوائل نباتية مختلفة وهى (نبات الهبسكس ،درنات البطاطس و العنب وثمار القرع العسلى) المصابة ببق الهبسكس الدقيقي .*Maconellicoccus hirsutus* (Green)
و قد أوضحت النتائج مايلى :

1- كان للعائل النباتى تأثير على فترات النمو لكل من اليرقات والعذارى حيث كان أفضل العوائل للمفترس هو نبات الهبسكس.

2- كان لاختلاف العائل النباتى تأثير على نسبة البقاء لليرقات حيث كان أعلى نسبة بقاء سجلت على البطاطس وأقل نسبة بقاء على ثمار القرع العسلي.

3- تأثر كل من صافى معدل الخصوبة ومعدل التزايد الحفيقي لمفترس *E. nigromaculatus* حيث سجلت أعلى المعدلات على نبات الهبسكس يليه ثمار القرع العسلي.

قام بتحكيم البحث

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