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Life-History Traits of the Predacious Mite, *Euseius scutalis* (Athias- Henriot) (Acari: Phytoseiidae) on Eggs of Three Insects (Lepidoptera: Noctuidae)

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ABSTRACT

Life history and reproductive parameters of the predatory mite *Euseius scutalis* (Athias-Henriot) were studied, to evaluate its potential as a predator of *Spodoptera littoralis* (Boisduval), *Spodoptera exigua* (Hûbner) and *Agrotis ipsilon* (Hufnagel) eggs as alternative diets in the laboratory. Total developmental time of the immature stages was the shortest 7.90±0.85 on eggs of *S. littoralis*, and the longest 9.5±0.86 on eggs of *A. ipsilon*. Fecundity was the highest on eggs of *S. littoralis* and *S. exigua* (19.8 eggs/female, 1.25 eggs/female/day and 18.22 eggs/female, 1.27 eggs/ female/day) and the lowest on *A. ipsilon* eggs (9.0 eggs/female, 0.90 eggs/female/day). *S. littoralis* eggs showed relative higher values of the net reproductive rate (Ro = 10.945), intrinsic rate of increase (rm = 0.14644) and finite rate of increase (λ = 1.1577 per day) than the eggs of *S. exigua* and *A. ipsilon*. *A. ipsilon* eggs resulted in the shortest female longevity, the lowest total fecundity, the lowest net reproductive rate (Ro = 5.40), intrinsic rate of increase (rm =0.10078) and finite rate of increase (λ =1.106) per day for *E. scutalis*.

Key Words: Acari, *Euseius scutalis*, life table parameters, lepidopteran eggs.

INTRODUCTION

Phytoseiid mites have very diverse dietary habits, ranging from generalists that feed on a variety of animal and plant foods, to specialist predators feed on tetranychid mites, and even to obligate monophagous predators (McMurtry, 1992). *Euseius scutalis* (Athias-Henriot) was described by McMurtry and Croft 1997, as a generalist (type IV predator), able to feed on a wide range of animal diets, but the reproductive potential was higher on pollen (El-Badry *et al.*, 1968; El-Badry and El-Banhawy, 1968; Bounfour and McMurtry, 1987 and Kasap and Sekeroglu, 2004). Several species of Phytoseiidae are known to feed on eggs and nymphs of thrips, whiteflies and scales; these insects may actually be preferred over tetranychid mites (Muma, 1971). *Neoseiulus cucumeris* (Oudemans) and *Neoseiulus barkeri* (Hughes) have been in numerous studies to be effective biological control agents for *Thrips tabaci* Lindeman, on greenhouse sweet pepers and cucumber (Klerk and Ramakers, 1986; Ravensberg and Altena, 1987 and Bonde, 1989). El-Badry (1968) stated that *Amblyseius aleyrodis* El-Badry was the most important acarine predator of cotton whiteflies, *Bemisia tabaci* (Gennadium). Nymphs of *Amblyseius rubini* Swirski and Amitai (= *E. scutalis*) preyed upon the nymphal and pupal stages of the thrips *Retithrips syriacus*, but a low percentage of the predator reached maturity (Swirski e*t al.*, 1967). *Amblyseius gossipi* El-Badry (= *Euseius scutalis*) was able to consume eggs and immature stages of the scale insect *Chrysomphalus aonidum* (L.), *Aonidiella aurantii* (Mask), *Lepidosaphes beckii* (Newn) and the mealybug *Icerya purchasi* (Mask) (Yousef and El- Halwany, 1982). Nomikou *et al.* (2003) demonstrated that *E. scutalis* was able to suppress whitefly populations on plants and is a candidate biological control agent for whiteflies such as *B. tabaci*.

The present study was performed to determine the relative nutritional value of some noctuid eggs as prey stages for the predacious mite *E. scutalis*. Survivorship, reproductive potential and life table parameters of the predator were evaluated.

MATERIALS AND METHODS

Prey and Phytoseiid predatory mite cultures

E. scutalis stock cultures were maintained using castor bean pollen, *Ricinus communis* L. as the food source. The predator was collected from sour orange trees (*Citrus aurantium* L.) planted at Fayoam Province. The mite cultures were established on leaves in a controlled rearing room (27±1°C, 70±5% RH).

Diets

Three diets of insect eggs, *i.e.*, *Spdoptera littoralis*, *S. exigua* and *Agrotis ipsilon* were used as an alternative prey stage for the phytoseiid *E. scutalis*. The newly laid eggs of *S. littoralis, S.exigua* or *A.ipsilon* were transferred to separate arena for feeding experiments (as described by El-Sawi and Momen, 2005).

Effect of *S. littoralis*, *S. exigua* and *A. ipsilon* eggs on the development and survival of the predatory mite *E. scutalis*

Arenas (3x3cm) of excised leaves, placed on water saturated cotton in plastic Petri dishes, were used to confine the predator. Predator eggs were transferred singly to the rearing discs, and the newly hatched larvae (0-12 h old) were supplied separately by each diet (egg patches) to be evaluated. Prey eggs consumed (completely or partially deflated) were replaced daily by another egg patches to maintain an ample food supply. Development of immature stages was observed at 12- h. intervals until they reached adulthood. Presence of an exuvium was used as a criterion for successful molting to the next developmental stage. The characteristics observed were incubation period of the egg stage, duration of larval, protonymphal and deutonymphal stages and survival rate (estimated from egg-adult survival). A male was introduced to each leaf disc when the female was in the last day of the deutonymphal stage for copulation. Mating took place after the third moulting, and an additional male was added to ensure successful mating. After copulation, the male was removed. Every 5-6 days, a new male was introduced to each arena for repeated mating.

Effect of *S. littoralis, S. exigua* and *A. ipsilon* eggs on the fecundity, longevity and life table parameters of the predatory mite *E. scutalis*

Newly-emerged mated females were confined individually on test arenas, along with the egg patches to be tested. Daily observation were made on individual newly emerged females from the development experiment to determine pre-ovipositional, ovipositional and post-ovipositional periods during the adult stage ; fecundity ; sex ratio of offspring and mortality. Phytoseiid eggs were collected daily and reared to the adulthood, and then sex ratio was determined by visual observation. Life table parameters were calculated according to Hulting *et al.* (1990).

Statistical analysis

One-way (ANOVA) was used to test the effect of prey eggs on the developmental parameters of *E. scutalis*. Assessment of significance was taken at 0.05 level probabilities (Duncan's Multiple test).

RESULTS AND DISCUSSION

Effect of prey eggs on the development and survival of the predatory mite *E. scutalis*

Individuals of *E. scutalis* developed successfully from larva to adult when they were fed on eggs of *S. littoralis*, *S. exigua* or *A. ipsilon* (Table 1). Development (egg- adult) was faster on *S. littoralis* eggs (7.9±0.86 days) than on *A. ipsilon* eggs (9.5±0.85 days), and of intermediate duration on *S. exigua* eggs (8.7±0.65 days) (Table 1). Survival rate was higher when the predator was fed on *S. littoralis* or *S. exigua* eggs (98 & 95% respectively), while a relative lower survival rate was recorded on *A. ipsilon* eggs (88%).

Table (1): Comparative durations (Mean ± S.D.in days) of female stage of *Euseius scutalis* when fed on eggs of *Spdoptera littoralis*, *S. exigua* and *Agrotis ipsilon* at 27±1°C and 70±5% RH.

Parameters	Prey host (eggs)			F. Statistic	Probability 0.05
	Spodoptera littoralis	*Spodoptera exigua*	*Agrotis ipsilon*		
Egg	2.70 ± 0.57	2.55 ± 0.51	2.72 ± 0.46	0.55398	0.5833
Larva	1.55 ± 0.51	1.72 ± 0.46	1.72 ± 0.46	0.8302	0.5552
Protonymph	1.65 ± 0.49 b	1.89 ± 0.68 ab	2.11 ± 0.32 a	3.7939	0.0282
Deutonymph	2.0 ± 0.56 c	2.44 ± 0.51 b	3.00 ± 0.59 a	15.2835	0.000009
Life cycle	7.90 ± 0.85 c	8.78 ± 0.65 b	9.50 ± 0.86 a	19.3751	0.000001
% Survival	98	95	88		
Pre oviposition period	1.45 ± 0.99 b	1.67 ± 0.69 b	2.89 ± 0.68 a	16.9818	0.000003
Oviposition period	2.50 a ± 16.05	15.67 ± 3.55 a	10.11 ± 1.71 b	28.1289	1.8366
Post oviposition period	2.75 ± 1.29 a	1.78 ± 0.81 b	1.61 ± 0.78 b	7.2686	0.00174
Adult longevity	2.99 a ±20.30	19.00 ± 3.11 a	14.61 ± 2.12 b	21.3278	3.9477
Life span	2.93 a ±28.20	27.83 ± 3.01 a	24.11 ±1.81 b	13.3752	0.00003
No. observation	20	18	18		

Means ± S. D. within a raw followed by the same letter are not significantly different at P≥ 0.05

Table (2): Life table parameters of *Euseius scutalis* reared on eggs of *Spdoptera littoralis*, *S. exigua* and *Agrotis ipsilon* at 27±1°C and 70±5% RH.

Parameter	Prey host (eggs)		
	Spodoptera littoralis	*Spodoptera exigua*	*Agrotis ipsilon*
Net reproductive rate (Ro)	10.945	9.4177	5.4
Generation time (days) (T)	16.3403	16.6724	16.73202
Intrinsic rate of increase (rm)	0.1464406	0.1345093	0.100789
Finite rate of increase (λ)	1.157706	1.143975	1.106043
Sex ratio (female/ total)	0.55	0.52	0.6
Fraction of eggs reaching maturity	1	1	1
Total number of eggs/ ♀(Mean ± S.D)	19.8 ± 5.89 a	18.2 ± 3.87 a	9.0 ± 2.03 b
Daily number of eggs/♀/day (Mean ± S.D)	1.2 ± 0.28 a	1.3 ± 0.34 a	0.9 ± 0.18 b

Means ± S.D within a row followed by the same letter are not significantly different at $P \geq 0.05$

Effect of prey eggs on the fecundity, longevity and life table statistics of the predatory mite *E. scutalis*

Pre-oviposition period was shorter for *E. scutalis* when fed on *S. littoralis* or *S. exigua* eggs than on *A. ipsilon* eggs (Table 1). *E. scutalis* had a significant longer ovipositional period and an adult longevity on eggs of *S. littoralis* or *S. exigua* (16.05, 20.30 and 15.66, 19.0 days, respectively) than on eggs of *A. ipsilon* (10.11 and 14.61 days) (Table 1). The highest ovipositional rate was on the eggs of *S. littoralis* or *S. exigua* (19.8 and 18.2 eggs/♀, respectively), while the lowest was on eggs of *A. ipsilon* (9.0 eggs/♀) (Table 2). The total number of eggs/female and the daily number of eggs/female/day for *E. scutalis* were not significantly different from each other when fed on eggs of *S. littoralis* or *S. exigua*, but it differed with *A. ipsilon* eggs as prey (Table 2).

Table 2 summarizes the effect of *S. littoralis*, *S. exigua* and *A. ipsilon* (eggs) as alternative food on the life table parameters of *E. scutalis*. It shows that a population of this predator could multiply 10, 9 and 5 times (Ro = 10.94, 9.42 and 5.40) in an equal generation time of 16 days (T = 16.34, 16.67 and 16.73) on the three prey eggs, respectively. It was also found that under these conditions, the intrinsic rate of increase (rm) was 0.146, 0.134 and 0.101 individuals/ female/ day for *E. scutalis* females when fed on eggs of *S. littoralis*, *S. exigua* or *A. ipsilon*, respectively, while the finite rate of increase (λ) was 1.158, 1.143 and 1.106) female daughters/ female/ day, respectively. The sex ratio of the progeny was female biased (female/ total = 0.55, 0.52 and 0.6) for the predator fed on *S. littoralis*, *S. exigua* or *A. ipsilon* eggs, respectively.

Few studies have been carried out on the life history of *E. scutalis* being fed on different insects. This study clearly showed that *S. littoralis*, *S. exigua* and *A. ipsilon* (eggs) provided commensurate nutrional effects on survivalship, longevity and fecundity of *E. scutalis* females. Romeih *et al.*, (2004) demonstrated that *E. scutalis* preyed on eggs of *Ephestia kuehniella* Zeller as an alternative food, completed its development in 7.2 days, and had an ovipositional rate of 22.0 eggs/ female at 25 C°, which agrees closely with the current finding in case of *S. littoralis* eggs. When fed on moving stages of *Tyrophagus casei* Oudemans and on an artificial diet (contains yolk, vitamin B1, B2 and B6, streptomycin, sulphate and sorbic acid), *E. scutalis* reached maturity in 10.2 and 13.9 days, respectively, which was close to the present results on *A. ipsilon* eggs (Rasmy *et al.*, 1987 and Abou-Awad *et al.*, 1992). Larvae of *Amblyseius rubini* (= *E. scutalis*) fed on the honeydew of the mealybug *Pseudococcus citriculus* died before reaching the protonymphal stage and did not reach maturity although some survived for ten days (Swirski *et al.*, 1967). The same authors reported that adult *A. rubini* provided with eggs of the moth, *Zeuzera pyrina* L, died within one or a few days, and only a few eggs were laid. Nomikou *et al.* (2003) reported that whitefly produced honeydew increased survival of *E. scutalis* but resulted in low oviposition and development. In comparison with other food tested (consider natural/main host) such as the eriophyid mite, *Eriophyes dioscoridis* Soliman and Abou-Awad, the tetranychid mite, *Panonychus citri* (McGregor) and pollen of *Malephora crocea* Jacq, the developmental time of *E. scutalis* was 6.5, 4.9 and 5.4 days, which was much shorter than present finding (Reda and El-Bagoury, 1986; Bounfour and McMurtry, 1987 and Kasap and Sekeroglu, 2004). Yousef and El-Halwany (1982) determined the durations of various adult stages, when *E. scutalis* was fed on *I. purchasi*, eggs and immature stages of *C. aonidum*, *L. beckii* and *A. aurantii*, which were shorter than in the present study. El-Sawi and Momen (2005) showed that both phytoseiid mites, *Typhloromips swirskii* (Athias-Henriot) and *Neoseiulus californicus* (McGregor) developed successfully (egg – adult) when fed on eggs of *S. littoralis* and *Phthorimea operculella* (Zeller) and the average of eggs deposited was 34.8 and 41.8 eggs/♀ for *T. swirskii* and 17.0 and 21.4 eggs/♀ for *N. californicus*, which were higher in the case of *T. swirskii* than the result of the present study. Recently, Momen and El-Sawi (2006) reported that eggs of *S. littoralis* and *A. ipsilon* were an excellent alternative prey for the predacious mite *Agistemus exsertus* Gonzalez, since the predator succeeded to complete its development on both diets with high reproductive rates of (68.9 and 49.9 eggs/♀, respectively). In the present study, the life table parameters suggested that both *Spodoptera* eggs were the most favorable food (regarding alternative food) for the population increase of *E. scutalis*. Net reproductive rate (Ro) of *E. scutalis* ranged 12.0- 26.0 females/female on *P. citri*, and 7.0 females/female on nymph of *Tetranychus urticae* Koch, of which the second is close to the current finding in case of *A. ipsilon* and *S. exigua* eggs (Kasap and Sekeroglu, 2004; Bounfour and McMurtry, 1987 and El-Laithy and El-Fouly, 1992). The same authors and Nomikou *et al.* (2001) reported a higher (rm) value for *E. scutalis* when fed on *P. citri* (0.16- 0.29 day), on pollen of *M. crocea* (0.188- 0.325 day) at 25 and 30 C°, nymph of *T. urtica* (0.146 day) and on *B. tabaci* (0.215 day) than the value recorded in the present study (0.11- 0.14 day). Present results of fecundity on *E. scutalis* fed on food tested ranged (19.8, 18.2 and 9.0 eggs/♀), which is close to that range reported by Yousef and El-Halawany (1982) with *A. gossipi* (= *E. scutalis*) fed on eggs and immatures of *C. aonidum* and immatures of *A. aurantii* (11.8- 23.6 eggs/♀). The highest rate of oviposition of *E. scutalis*, on natural host, was recorded on *E. dioscorides* (62.8 eggs/♀), *P. citri* (39.7 eggs/♀) and *Eriophyes lycopersici* (Wolffenstein) (27.0 eggs / ♀) (Reda and El-Bagoury, 1986; Kasap and Sekeroglu, 2004 and Abou-Awad, 1983). Much lower rate of eggs laid by *E. scutalis* was recorded on artificial diet consisted of milk, cystine, arginine, sucrose, streptomycin, sulphate and sorbic acid (0.35 eggs /♀/day) and on eggs and immatures of *L. beckii* (3.3 and 6.2 eggs/♀) and *I. purchasi* (1.7 and 1.2 eggs/♀) (Abou-Awad *et al.*, 1992; Yousef and El-Halwany, 1982).

As concluded, eggs of *S. littoralis*, *S. exigua* and relatively *A. ipsilon* are good alternative source of nutrition for the predacious mite *E. scutalis*. Alternative and supplementary food can play an important role in nutrition of predatory mites of the family Phytoseiidae (Overmeer 1985). The present laboratory experiments stated that several food types tested were accepted for some phytoseiids under laboratory conditions, but might not be relevant under field conditions.

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