Predator-Prey Preferences and Life-Table-Parameters of *Cheletogenes ornatus* (Canestrini & Fanzago) to Red Palm Mite *Raoiella indica* Hirst and Date Scale-Insect *Parlatoria blanchardii* (Targ.)

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ABSTRACT

The mite, *Cheletogenes ornatus* (C.&F.) was reared on three different types of food, eggs and immatures of *Raoiella indica* Hirst (Acari: Tenuipalpidae), and crawlers of date-scale-insect, *Parlatoria blanchardii* (Targ.) at laboratory conditions (15± 2°C and 50±5% R.H.). This study showed that female predator had two nymphal stages; while the male had only one. The predatory mite was noted under date-scale insects at date-palm-trees with a high numbers. The population of predator increased following the increase of the tenuipalpid mite, *R.indica* during in October to February. The results showed that high capacity of predator population growth revealed the high ability of the predator to suppress *R.indica* and *P. blanchardii* populations on date palm. Predation potential was greatest for larvae, followed by protonymphs, then deutonymphs. Predator consumed an average of 106.8 &158.2 preys for male and female during its life span, respectively. Cannibalism was noticed when food was absent. The mean generation time (T) of the predatory mite, *C. ornatus* was significantly affected by the type of food. The longest time needed for one generation (21.23) times was recorded when mite fed on crawlers of date-scale-insect, whereas the shorter period was (18.65) days when fed on eggs of *R. indica*. The population of predator had capacity to double (DT) every (3.38, 3.48 and4.01 times) within a single generation when fed on the three different types of food, respectively. Eggs of *R. indica* was the most preferable food compared with those tested as it recorded the highest value of (r_m) 0.205 .It was clear that Finite rate of predator increase (**λ**) had capacity to multiply about (1.227; 1.219; 1.189) times/female/day and Gross reproductive rate (GRR) was (59.16; 55.99 and 49.22) times/female/day when reared on the three different foods, respectively.

Key Words: *Cheletogenes ornatus*, Life table parameters, biocontrol, date-palm-trees, *Raoiella indica*, *Parlatoria blanchardii*.

INTRODUCTION

Date palm, *Phoenix dactylifera* L. is one of the most important horticultural crops in the Middle East. Arab countries are the main source of date palm in the world, Mohamed, (1982). The production of dates, according to the recent FAO statistics in the Arab countries, is about 4,332,208 metric tons, which accounts to 71.69% of international production (FAO, STAT, 2006). The date palm and its fruits are subject to attack by several pests that are, in most cases, well adapted to the oasis environment. Damage caused by pests is considerable and leads to heavy economic losses. The genus *Raoiella* is best known because of the red palm mite, *Raoiella indica*, a major pest of palm trees. No much is known about the biology, geographic origins, or evolutionary history of the genus when *R. indica* emerged as a major invasive pest. The red palm mite (RPM) has been observed attacking date-palm-trees in Dokki, Giza, Egypt with high numbers during October to January.

The present work aims to understand the reproduction of the cheyletid mite, *Cheletogenes ornatus* **(**C. & F.), biological aspects and life table parameters as an important agent for controlling date-scale-insect and the phytophagous flat mite, *R. indica* which considered the most destructive pest attacking date palm trees.

MATERIALS AND METHODS

1- Eggs and immatures of the tenuipalpid mite, *Raoiella indica* Hirst:

Development and reproduction of *R. indica* on leaves of *P. dactylifera* were studied under laboratory conditions at 15±2°C and 50±5% R.H. The rearing substrate was leaf discs of *P. dactylifera* placed in Petri dishes (5 cm diameter) with water-saturated cotton. Gravid females of *R. indica* were transferred to leaf discs of palm trees and allowed to lay eggs. The mite eggs and immatures were transferred to the predator when needed; then counted and replaced by other ones.

2- The crawlers of date scale insects:

The crawlers of date scale insects were found and collected from leaves of date palm trees where the predator fed on it.

Culture of the predatory mite:

Females of cheyletid mites, *C. ornatus* were taken from leaves of date palm trees and transferred to rearing substrates. Females were left 24 hours and their oviposited eggs were used for biological aspects. Leaf discs of the date-palm-trees (5 cm in diameter) were used as rearing arenas. The discs were placed on cotton wool soaked with water in Petri-dishes. Newly laid eggs of the predator, were left into the rearing

discs. This experiment was repeated with all tested preys. Different biological aspects were daily recorded.

Data were statistically analyzed by ANOVA-test to compare means (L.S.D-test, where P>0.05).To study the effect of different prey species at temperature15±2°C and 50±5% R.H. on life-table-parameter; parameters of *C. ornatus* were followed the formula of Andrewwartha and Birch (1948) and Basic computer program of Abou- Setta *et al*. (1986), were followed.

RESULTS AND DISCUSSION

The predatory mite, *C. ornatus* was found showing a conspicuous red coloration of the alimentary tract indicating recent feeding on *R. indica*. Females of the predatory mite passed through two nymphal stages before reaching adulthood; while predatory male passed through only one stage. This results agree with, those of Zaher *et al*. (1981) and Moraes *et al*. (1989). *C. ornatus* was noticed to be associated with tenuipalpid mites and to chase its prey as it waits in ambush under old scale shields crawlers; Avidov *et al*.(1968); Arruda *et al*.(1969); and Saglam and Cobanoglu (2010)

Incubation period:

As shown in Table 1, the incubation period of C. *ornatus* was greatly affected when fed on different tested foods. The shortest incubation period was noticed for resulted females in case of feeding on eggs of *R. indica* (1.55 days), but the longest period was recorded when the male fed on the crawlers (2.73 days). The statistical analysis of the obtained data showed that L.S.D at 0.05 level was (0.263) and (0.244) for the effect of food and both sexes (males and females).

Life cycle:

Table1 showed that the duration of life cycle for both sexes were highly affected by the type of food employed. The total period averaged 9.33,10.15 and 14.88 days for male and 13.5,14.68 and 15.78 days for female when reared on eggs and immatures of *R. indica* and the crawlers of date-scale-insect, *P. blanchardii*, respectively.

Similar results were obtained by Gerson *et al*., 1990 observed the predatory mite, *C. ornatus* feeding on crawlers in many parts of the world. Zaher and Soliman, (1971) noticed that *C. ornatus* occured throughout Egypt on fruit trees and ornamental plants and plays an important role in the control of coccids.

Also, Zaher *et al*. (1981) reared *C. ornatus* on eggs and immatures of two scale insects and two tetranychoid mite species, at 25°C.

El-Halawany *et al*. (1984), observed, *C. ornatus* in high numbers associated with phytophagous mites and scale insects infestation in all egyption governorates, where date palm is planted. In Brazil, Moraes, *et al*. (1989) reported that, *C. ornatus* was the most common predator of *Pinnaspis aspidistrae* (Signoret) at 28±5°C and they recorded the duration of the life cycle was (40.6 and 31 days for ♂♂ and ♀♀), respectively. Females had 2 nymphal stages; while the only male obtained in the laboratory had a single nymphal stage. *C. ornatus* reproduced by parthenogenesis, and ♀♀ were seldom produced. The peak reproduction rate was 0.31 eggs /♂/day, and the peak prey consumption rate was 0.8 crawler of *P. aspidistrae* /♂/day. Pena *et al.* (2009) reported *Cheletomimus* sp. preying on *R. indica* and its densities increased as *R. indica* grew and spread to a new locations.

Adult longevity:

Adult longevity of *C. ornatus* was highly influenced as by different types of the tasted food, (Table 1). This period averaged 24.21, 25and 26.6 days for female and 18.9, 20.7and 23.8 days for male when fed on eggs and immaturs of *R. indica* and crawlers of the data scale insect, respectively. However, each of pre-oviposition, oviposition and post-oviposition periods were affected by the type of food used, where the eggs of *R. indica* were the most suitable food during the oviposition period (15.5 days) of predatory females.

Similar results were obtained by, El-Banna, *et al*. (2014) who noticed the predatory mite, *Amblyseius hutu* (Pritchard & Baker) may clarify its potential as a biological control agent for date scale insect, *P. blancharidii* which attacks date palm trees, and the adult longevity of gamasid mite was highly influenced prey type.

Predator female fecundity:

As shown in table 2, *C. ornatus* female deposited an average of 104, 98 and 88 eggs when fed on eggs and immatures of *R. indica* and crawlers of the date-scale-insect, *P. blanchardii*, respectively.

Predation capacity:

The male and female of the predatory mite, *C. ornatus* have a high predation capacity when fed on crawlers of date scale insect and immatures of flat mite, respectively (Table 3). The number of consumed prey individual differed according to types of food and stage of introduced prey. The predator predation potential was greater for eggs followed by larvae, protonymphs then deutonymphs of *R. indica*. Food consumption during its life cycle averaged

Table (1): Developmental durations in days of *Cheletogenes ornatus* (C. & F.) when reared on three different foods at 15±2^{0}C and 50±5% R.H.

Developmental stages		Food types			L.S.D.	F-Test	Probability
		R. indica		Crawlers of date scale-insect			
		Eggs	Immatures				
Incubation periods	♂	1.88 [a] ±0.37	1.65 [a] ±0.24	1.55 [a] ±0.23	0.263	1.92	0.166 ns
	♀	1.55 [c] ±0.23	2.18 [b] ±0.33	2.73 [a] ±0.22	0.244	48.79	0.0000***
Larva	♂	3.25 [c] ±0.35	3.75 [b] ±0.26	6.0 3 [a] ±0.52	0.356	145.62	0.0000***
	♀	4.22 [b] ±0.93	4.8 [a] ±0.59	4.8 [a] ±0.99	0.393	5.316	0.0113*
Protonymph	♂	4.28 [c] ±0.38	4.75 [b] ±0.24	7.3 [a] ±0.69	0.659	116.07	0.0000***
	♀	3.98 [a b] ±0.36	4.35 [a] ±0.47	3.75 [b] ±0.44	0.393	5.01	0.0142*
Deutonymph	♀	3.73 [b] ±0.39	2.95 [c] ±0.21	4.58 [a] ±0.41	0.316	62.65	0.0000***
Total immatures	♂	7.53 [c] ±0.49	8.5 [b] ±0.41	13.53 [a] ±1.07	0.659	186.84	0.0000***
	♀	11.96 [c] ±0.67	12.45 [a b] ±1.01	13.13 [a] ±0.54	0.701	4.973	0.0145*
Life cycle	♂	9.33 [c] ±0.37	10.15 [b] ±0.58	14.88 [a] ±1.18	0.724	144.02	0.0000***
	♀	13.5 [c] ±0.73	14.68 [b] ±0.94	15.78 [a] ±0.42	0.666	24.581	0.0000***
Adult longevity	♂	18.9 [b] ±1.45	20.7 [b]± 0.67	23.8 [a] ±1.03	1.01	35.14	0.0000***
	♀	24.21 [c] ±1.55	25.0 [b] ±0.11	26.6 [a] ±1.07	0.999	12.6	0.0001***
Life span	♂	29.23 [c] ±1.22	30.85 [b] ±0.97	38.88 [a] ±1.03	0.991	219.08	0.0000***
	♀	37.72 [c] ±1.41	39.63 [b] ±0.94	42.38 [a] ±1.36	1.15	35.15	0.0000***

Table (2): Effect of feeding the predatory mite, *C. ornatus* on the different stages of red palm mite and date scale insect on oviposition period.

Prey stages		Duration			No. of deposited eggs	
		Pre-oviposition	Oviposition	Post-oviposition	Total eggs	Eggs/day
Raoiella indica	Eggs	1.63±0.32[b]	18.88±1.69 [a]	3.7 ± 0.33[b]	104[a] ±12.01	**5.51 [b] ± 4.9**
	Immatures	3.7[a] ±0. 19	15.5±0.53[c]	5.8 ±0.56 [a]	2.18±98 [b]	6.37 ±0.28[a]
Crawlers of scale insect		4.0±0.75[a]	17.15 ±0.94 [b]	5.45±0.81[b]	88 ±1.28[c]	5.13[b] ± 0.33
L.S.D		0.446	1.066	0.549	6.503	0.421
Probability		0.0000***	0.0000***	0.0000***	0.0001***	0.0000***
F-Test		70.77	21.11	35.33	13.36	18.87

Table (3): Food consumption of the predator, *C. ornatus* when fed on different preys at 15 °C &50% R.H.

Periods		No. of devoured prey individuals				
		Crawlers of date scale insect, *P. blanchardii*	Immatures of red palm mite, *R.indica*	LSD	F-test	Probability
Life cycle	♂	18.8 [b] ±1.55	31.6 [a] ±3.59	2.601	106.85	0.0000***
	♀	23.5 [b] ±2.12	40.5 [a] ±2.07	1.968	329.24	0.0000***
Longevity	♂	73.5 [b] ±7.07	81.2 [a] ±5.49	5.95	7.389	0.0141*
	♀	85.4 [b] ±5.15	116.2 [a] ±12.7	9.114	50.4	0.0000***
Life span	♂	81.4 [b] ±8.86	106.8 [a] ±11.75	9.78	29.78	0.0000***
	♀	108.9 [b] ±5.15	158.2 [a] ±11.75	8.526	147.55	0.0000***

Table (4): Life table parameters of *Cheletogenes ornatus* (C. &F.) females when fed on three different foods in laboratory at 15 ± 2^{0}C and 50 ±5 % R.H.

Prey species	Eggs of *R. indica*	Immatures of *R. indica*	Crawlers of *P. blanchardii*
Mean generation time (T_c) [a]	18.65	8.98	21.23
Doubling time (DT) [a]	3.38	3.48	4.01
Net reproductive rate (R_o) [b]	45.68	43.56	39.11
Intrinsic rate of increase (r_m) [c]	0.205	0.199	0.173
Finite rate of increase (λ)	1.227	1.219	1.189
Gross reproduction rate (GRR)	59.16	55.99	49.22

[a] Days [b] per generation and [c] Individuals/female/ day

(18.8 & 31.6) and (23.5 & 40.5) prey for male and female when fed on the first instar of scale insect and immatures of flat mite, respectively; while, during life span were (81.4 & 106.8) and (108.9 & 158.2) prey for the same preys, respectively.

Zaher& Soliman (1971) reported that the predator, *C. ornatus* was successfully reared on the olive scale insects, *Parlatoria oleae* (Colveée). Wafa, *et al*. (1970) reported that the adult female and male of *Eutogenes africanus* Wafa & Soliman consumed an average of 186 and 156 eggs of *P. oleae*, respectively. The female life cycle averaged 31 days during which it deposited 16 eggs at 29°C.

Other cheyletids were observed feeding on armored scale insect crawlers, in the field such as, *Hemicheyletia bakeri* (Ehara) which feeds on the yellow scale insects, *Aonidiella citrine* (Coquillett) in Florida, Muma,(1975) and *Cheletominus berlesei* (Oudemans) fed on the lantania scale, *Hemiberlesia lataniae* (Signoret) and hemisarcopted mites in California and on *Parlatoria* spp. in Israel, Gerson(1967) and Gerson *et al.* (1990).

Life table parameters:

The mean generation time (T) of the predatory mite, *C. ornatus* was significantly affected by the type of food (Table, 4). The longest time needed for one generation (21.23) times was recorded when mite fed on crawlers of date-scale-insect while, the shorter was (18.65) days when fed on eggs of *R. indica*. The predatory mite had life table parameters as follows, mean generation time (T) 18.65;18.98 and 21.23 days; net reproductive rate (R_o) 45.68; 43.56 and 39.11 per generation; intrinsic rate of natural increase (r_m) was (0.205; 0.199 and 0.173) times; finite rate of increase (λ) (1.227 ,1.219 and 1.189) times/female/day and gross reproductive rate (GRR) 59.16 ;55.99 and 49.22 times/female/day and doubling time (DT) values 3.38 ; 3.48 and 4.01 days when female fed on three different foods mentioned above, respectively.

Carrillo and Peña (2010) observed *Amblyseius largoensis* (Muma) feeding on the invasive species *Raoiella indica* Hirst and increased in numbers after the arrival of *R. indica* in south Florida. They evaluated the development and reproduction of *A. largoensis* feeding on pollen, *R. indica*, and other microarthropods inhabiting coconuts in Florida. The intrinsic rate of increase (r_m) of *A. largoensis* fed on *R. indica* was significantly higher than those fed on the other food sources ($F = 34.18$; $df = 2, 58$; $P<0.001$). *A. largoensis* showed higher survival and reproductive rates, and shorter developmental times when fed solely on *R. indica* compared with single other food sources. Results of their studies suggested that *A. largoensis* could play a role in controlling *R. indica* in Florida.

In the present article, *Chelotogenes ornatus* was a biological control agent for *R. indica* and might be able to reduce the population of red palm mite, *R. indica* in Egypt.

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