

Effect of Temperature on Biological Aspects, Fecundity and Life Table Parameters of the Predatory Mite, *Cheyletus malaccensis*

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Abstract

The predatory mite, *Cheyletus malaccensis* (Oud.) was recorded to be the communist predacious mites of family Cheyletidae, it was found associated with other different mite species and immature stages of insects, which were collected from palm tree fibers in Damietta Governorate.

Biological aspects, fecundity and life table parameters of *Cheyletus malaccensis* were studied under laboratory conditions at 25 and 35 °C and 65% R.H. Feeding on Immatures of *Tyrophagus putrescentiae*. Obtained results showed that the developmental stages of both female and male were affected by temperature as a vital environmental factor, were as its decreased as well as temperature increased.

Also, deposited an average of 98.9 and 57.75 eggs during 54.18 and 13.1 days, with a daily rate of 1.8 and 4.5 eggs at 25 and 35 °C. Life table parameters showed highest value of the net reproductive rate (R_0) as 62.83 at 25 °C. Sex ratios were 0.46 for both temperatures.

Keywords: Biology, Cheyletid mites, Life tables, Date palm trees.

Introduction

Mites are one of the major pests that living in a wide range of habitats. Members of the family Cheyletidae are worldwide distribution, which found in different localities associated with different pests infesting different crops as well as stored products; its known that, they feeding on different stages of acari mites and most immature stages of insects (Taha et al., 1988; Sarwar, 2012 & 2015; Rodrigues, 2020). Date palm, *Phoenix dactylifera* L. is known as

one of the oldest and most valuable fruit trees in the world especially in middle east region, and is mentioned in Holy Qur'an and Bible. Also, Date palm is one of the most important fruit trees in Egypt and Arab countries because it's importance as export cash crop (Zaid A. (Ed), 2002). More than three quarters of palm trees are cultivated in the Middle East (Johnson, 2010).

Recently, the cultivation of palm trees is being expanded greatly in Egypt, due to the great interest on the part of the Egyptian government to expand and increase the

domestic product of dates. Due to the currently thriving trade in palm trees and fruits between many countries, many pests have moved and settled in new places, forcing farmers to increase the use of pesticides, which negatively affect the climate (Wakil et al., 2015).

The date palm trees and its fruit are subject to attack by several Mites, insects and pests which mostly caused a great damage to the trees and their fruits, which leads to heavy morphological and economical losses (Mosbah and Omar, 2014; Taha, et al., 2014). Increase knowledge about mite biology has a great importance to predict their harm and to control them. This work studying the effect of temperature and relative humidity on biological aspects, fecundity and life table parameters of the *Cheyletus malaccensis* when fed on immature stages of the acarid mite, *Tyrophagus putrescentiae* reared in laboratory conditions.

Materials and Methods

Culture of the prey Tyrophagus putrescentiae:

The prey *Tyrophagus putrescentiae* were collected from date palm leaves and populations were reared on Baker's yeast granules in small petri dishes of 15 cm diameter at room temperature. Thus, eggs and immature stages of prey were easily produced for supply the *Cheyletus malaccensis* during the biological studies.

The predatory mite, *Cheyletus malaccensis* (Oud.) was collected from leaves and fibers of date palm trees, in Damietta Governorate.

Pure culture of the predatory mite, Cheyletus malaccensis was originated on immature stages of the acarid mite, Tyrophagus putrescentiae:

The predatory mite *Cheyletus malaccensis* was reared singly using small hemispherical plastic cell of 0.5 inch in diameter and less than 0.25 inch in depth (Taha et al., 1988). A layer of Cement, Clay and Charcoal mixture filled on bottom of the plastic cell with ratio of 1, 2 and 7 respectively to depth of needle to make convex-concaved areas for predator mite rearing (Mosbah, 2020).

Cells were covered with small glass slides. A suitable moisture in the previous

mixture was obtained by adding three drops of water daily (Taha et al., 1988). Suitable numbers of immature stages of *Tyrophagus putrescentiae* introduced to each predator of Cheyletid mite and devoured ones were replaced by fresh ones during all stages of biological studies under laboratory conditions of 25 & 35 °C and 65% R.H.

Statistical analysis

The comparison between means and standard deviations was tested for significance using ANOVA analysis. The relationships among parameters were assessed using Pearson's correlation coefficient and regression correlation. SPSS (version 20 for windows), Origin (6) and Excel (2016) were used for statistical analysis, while Life table parameters were calculated according to Andrewartha and Birch (1954) using software developed by (Abou-setta et al., 1986).

Results and Discussion

The wide spread and activity of cheyletidae mite ensure the considerable importance and wide variation in their feeding behavior including mites and immature stages of insects (Taha et al., 1988).

Cheyletus malaccensis was found associated with large number of acarid mites and other arthropod pests associated with date palm trees. The predatory mite, *Cheyletus malaccensis* moved actively here and their searching for the prey even mites or immature stages of insects catching them by the pedipalps and piercing it chelicera sucking most of its contents.

Cheyletus malaccensis was reared on immature stages of the acarid mite, *Tyrophagus putrescentiae* at 25 & 35 °C and 65% R.H., under laboratory conditions, whereas both sexes of *Cheyletus malaccensis* pass through, egg, larva, protonymph, deutonymph and adult for female but deutonymph stage for male was not observed (Taha et al., 1988) when they study the biology of *Cheyletus malaccensis*.

Biological aspects of Cheyletus malaccensis (Oudemans):

Hatching: The egg is elongate oval has a white color, when newly deposited. Color

gradually changed to whitish as incubation period, when incubation proceeded.

Molting: Before molting, the active larva or nymph entire into a quiescent stage which are stop to feeding and moving. The exuviae splits transversely and the next stage withdraws its front legs then crawled forward leaving the old skin.

Mating: When male emerges; it runs searching for a quiescent female deutonymph and stays down beside her. The copulation takes place immediately after female emerges.

Oviposition: Female laid eggs singly near each other to appear in groups of 5 – 15 eggs each and protect them from enemies by standing near and removing around in their area.

The predatory mite, Cheyletus malaccensis developmental stages:

The incubation period of female and male lasted for (7.36 & 6.85) and (2.17 & 2.08) days at 25 and 35 °C. These results indicated that the incubation period was greatly affected by temperature degrees. This results were agreed with (Taha et al., 1988; Hassan et al., 2014; Mesbah, 2020).

The immature stages:

Mean obtained biological developmental stages of the predatory mite, *Cheyletus malaccensis* (Table 1) showed that increasing temperature affected all predator stages. The total immature lasted 20.55 and 12.67 days for female at 25 and

35 °C, while male total immature stayed (12.62 & 7.5) days. These results coincided with that obtained by (Klokk and Harrison, 2013).

Life cycle, as shown in Table (1) female duration (27.9 & 14.83) days when it reared on immature stages of *Tyrophagus putrescentiae* at 25 and 35 °C while, male life cycle lasted (19.46 & 9.58) days at the same pattern respectively.

Adult longevity lasted (66.45 & 18.33) days for female and (55.23 & 17.27) days for male respectively, when they reared at 25 and 35 °C under laboratory conditions.

As shown in Table (2) female oviposition period lasted (54.18 & 13.08) at 25 and 35 °C while, female fecundity averaged of 98.91 eggs at 25 °C followed by 57.75 eggs at 35 °C, with a daily rate of 1.8 and 4.5 eggs, therefore 25 °C was considered the suitable temperature for rearing the predatory mite, *Cheyletus malaccensis* as a bio-control agent. These results agree with that obtained by (Taha et al., 1988; Hassan et al., 2014; Mesbah and Omar, 2014).

Life table parameters were estimated as Mean generation time (T) as 48.66 and 22.86 days, net reproductive rate (R₀) as 62.83 and 36.38 per generation, the intrinsic rate of natural increase (r_m) as 8.51 and 0.16 days, finite rate of increase (exp_{r_m}) as 1.09, 1.17 offspring/individuals/day and sex ratio (female/total) 0.46 % for both temperature degrees Table (3). These results agreement with that obtained by (Hofmann et al., 2003; Cui et al., 2008; Palyvos and Emmanouel, 2009; Huang et al., 2019).

Table (1) Duration of different stages of *C.malaccensis* when reared under laboratory conditions at 25 and 35 °C and 65% R.H.

Stages	Male				Female				
	Temperature		F-value	P-value	Temperature		F-value	P-value	
	25	35			25	35			
Egg	6.85±1.07	2.08±0.28	438.214	<0.001	7.36±1.21	2.17±0.4	200.783	<0.001	
Larvae	A	5.23±1.01	3.38±0.51	98.108	<0.001	5.91±0.7	3.58±0.5	83.304	<0.001
	Q	1.92±0.28	0.92±0.19	111.185	<0.001	1.82±0.4	1.08±0.3	25.492	<0.001
Protonymph	A	4.15±0.8	2.31±0.43	123.4	<0.001	4.73±0.47	2.75±0.47	106.32	<0.001
	Q	1.31±0.48	0.88±0.22	25.222	<0.001	1.64±0.5	0.96±0.15	19.969	<0.001
Deutonymph	A	-	-	-	-	4.36±0.5	3.21±0.41	37.632	<0.001
	Q	-	-	-	-	2.09±0.7	1.08±0.3	21.002	<0.001
Total immature	12.62±1.89	7.5±0.61	508.726	<0.001	20.55±1.44	12.67±0.65	294.615	<0.001	
Life cycle	19.46±2.82	9.58±0.73	1597.551	<0.001	27.91±1.3	14.83±0.7	912.76	<0.001	
Longevity	55.23±4.4	17.27±1.55	22065.149	<0.001	66.45±4.48	19.33±1.6	1166.585	<0.001	
Life span	74.69±5.78	26.85±1.91	35537.077	<0.001	94.36±4.95	34.17±1.51	1628.307	<0.001	

Table (2) Adult female of *C.malaccensis* longevity and fecundity when reared under laboratory conditions at 25 and 35 °C and 65% R.H.

Temp	Preovi	Ovi	Postovi	Longevity (days)	Fecundity	
	position period (days)				Total egg	Daily rate
25	6±1.3	54.18±4.31	6.27±4.31	66.45±4.48	98.91±11.29	1.83±0.24
35	2.58±0.52	13.08±1.64	3.67±0.79	19.33±1.6	57.75±6.82	4.51±0.92
F-value	128.879	940.054	18.251	1166.585	110.773	78.768
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table (3) The effect of the two temperatures (25 and 35 °C) on life table parameters of *C.malaccensis*

Parameters	Temperature	
	25 C	35 C
Net reproduction time (R ⁰)	62.83	36.38
Mean generation time (T)	48.66	22.86
Intrinsic rate of increase (r _m)	8.51	0.16
Finite rate of increase (exp _{r_m})	1.09	1.17
sex ratio (female/total)%	0.46	0.46

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الملخص العربي

عنوان البحث: تأثير درجة الحرارة على الجوانب البيولوجية و الخصوبة و معاملات جدول الحياة للعث

المفترس Cheyletus malaccensis المتغذي علي Tyrophagus putrescentiae (Acari: Actinidida: Cheyletidae)

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تم تسجيل العث المفترس ، *Cheyletus malaccensis* (Oud.) على أنه أكثر عائلة Cheyletidae انتشاراً، وقد وجد مرتبطاً بأنواع أخرى من العث وبعض يرقاتها الغير ناضجة من الحشرات ، والتي تم جمعها من ألياف شجرة النخيل في محافظة دمياط. تمت دراسة الجوانب البيولوجية والخصوبة ومعايير جدول الحياة في *Cheyletus malaccensis* تحت ظروف معملية عند ٢٥ و ٣٥ درجة مئوية و ٦٥٪ رطوبة نسبية عندما تمت تغذيته علي يرقات *Tyrophagus putrescentiae* أظهرت النتائج التي تم الحصول عليها أن مراحل النمو لدى كل من الإناث والذكور قد تأثرت تأثيراً عكسياً بدرجة الحرارة كعامل بيئي حيوي . كما تم وضع ما معدله ٩٨,٩ و ٥٧,٧٥ بيضة خلال ١٨,٥٤ و ١٣,١ يوم بمعدل ١,٨ و ٤,٥ بيضة عند ٢٥ و ٣٥ درجة مئوية علي الترتيب. كما أظهرت معاملات جدول الحياة أعلى قيمة لصادفي معدل التكاثر (Ro) حيث بلغت ٦٢,٨٣ عند ٢٥ درجة مئوية. كانت النسب بين الجنسين نفسها بمعدل ٠,٤٦ لكلتا درجتى الحرارة.