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BIOLOGICAL STUDIES AND LIFE TABLE PARAMETERS OF *Phyllotetranychus gawadii* HALAWA, MESBAH & MOHAMED (ACARI: TENUIPALPIDAE) REARED AT TWO TEMPERATURES

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ABSTRACT

The development, survival and life table parameters of the tenuipalpid mite, *Phyllotetranychus gawadii* Halawa, Mesbah & Mohamed fed on date palm, *Phoenix dactylifera* L. leaves were determined at 25 and 30±2° C and 65±5%R.H. in laboratory. The data showed that female and male had three nymphal stages before reaching adulthood. The tritonymphal stage was recorded for the first time. The shortest periods of the incubation period, immature stages and longevity were (13.23, 36.83, 65.58) days and (12.18, 25.03, 48.40) days for female and male, respectively, at 30ºC. The temperature 30 ºC enhanced the maximum value of intrinsic rate of increase (r_m) 0.0629 individuals / ♀ / day, and maximum net reproductive rate (R_0) 44.01 individuals / generation. Maximum fecundity was obtained at 30ºC after 64.87 days as 3.86 eggs / ♀ / day. The mean generation time (T) and generation doubling time (DT) values had affected by temperature.

Keywords: Tenuipalpidae, *Phyllotetranychus gawadii*, reproduction, life table, date palm.

INTRODUCTION

Date palm trees, *Phoenix dactylifera* L. is one of the oldest known fruit crops and had been cultivated in North Africa and the Middle East for at least 5000 years (Zohary and Hopf, 2000). Damage caused by pests is considerable and lead to economic losses. Zaid *et al*., (2002) stated that date palms are attacked by many pests and diseases and their nature and severity vary with cultivar, location, weather and cultural practices. The tenuipalpid species (Acari: Prostigmata) are phytophagous and some of their damages on the plant hosts are economically important, They feed directly from the epidermal cell and sub epidermal tissue like mesodermal cells, leaves and fruits (Mesa *et al*. 2009; Beard *et al*. 2012). Although, mites belonging to family Tenuipalpidae play an important role in Egyptian agricultural ecosystem, the biological studies on this group are extremely rare (Mohamed *et al*.، 2014, Halawa & Fawzy, 2014). The most published studies on these mites were conducted on ecology (El-Sanady & Mohamed, 2013; Radwan & Attia, 2013; Mesbah & Omar, 2014). *Phyllotetranychus* Sayed one of the family Tenuipalpidae genera which included only three species *P. aegyptiacus* by Sayed (1938), *P. romaine* Pritchard and Baker (1958) and *P. gawadii* Halawa, Mesbah and Mohamed (2015). All of them attacking palm trees. Studies on genus *Phyllotetranychus* extremely rare this might be due to absence of interested. Moreover, *P. aegypticus* species was reared by Zaher, *et al*. (1969), this mite has only one nymphal stage and its life cycle lasted for about five days. While *Phyllotetranychus romaine* species is not common where it recorded in few countries and was described one time as a new species by Pritchard and Baker (1958). *P. gawadii* was erected as new species on date palm leaves at Giza province by Halawa *et al*. (2015). The present work aims to study the biology and life table parameters of *P. gawadii* at two temperatures.

MATERIALS AND METHODS

Stock culture and design of experiment:

This study was conducted at two constant temperatures 25 and 30 ± 2ºC and 65% RH. Stock culture was obtained from heavily infested date palm leaves from Giza Governorate, during season 2014. The duration of *P. gawadii* developmental stages was studied on excised leaf discs of date palm in the laboratory. Square leaf discs, each 3cm in diameter were placed on a cotton wool bed in Petri dishes (5 X 6 cm) with the upper surface. The cotton bed was soaked with water twice daily to maintain the leaf discs fresh. Adult females of *P. gawadii* were transferred from the stock culture to each disc for laying eggs about two weeks where 100 freshly laid eggs were available in the same age. The obtained eggs were observed daily and hatched larvae were divided in two major groups, 50 larvae according to tested temperature, kept separately on a disc for recording duration of different biological aspects. Leaf discs were replaced with fresh ones when needed. For determining the fecundity of mated females, each female tritonymph was kept with a male. The number of laid eggs was recorded during the oviposition period. Data were statistically analyzed by ANOVA-test to compare means (L.S.D-test, where P>0.05) and Life table parameters were estimated according to (Birch, 1948) using the Life 48, BASIC Computer program (Abou-Setta *et al*., 1986).

RESULTS AND DISCUSSION

Biological aspects of *P. gawadii* on date palm leaves at two temperatures:

Moulting

Before moulting every active immature of *P. gawadii* enters a quiescent stage during which it stops feeding and movement, stretching its legs forward and posterior legs backward. *P. gawadii* inserts the mouth parts into the plant tissues. During these quiescent

stages the skin becomes glimmering reddish purple with glassy appearance. A transverse rupture of the skin encircles the larval body behind the posterior legs, then it disengages itself only from the anterior part of the old skin (that of prosoma). It is of interest to note that the emerging adult gets rid from the all the nymphal exuvia with that remained of the larval posterior part, this result harmony with that obtained by Zaher *et al*. (1969b).

Mating

Adult females are larger than males and less active. Males and females are sexually mature when they emerge and males actively seek out females, suggesting there is a sex pheromone involved. When a male locates a female tritonymph in the quiescent stage, he will settle close to it and wait for up to two days for her to molt. When female tritonymph begin to molt, the male becomes active and moves under her, bending his posterior up and forwards to mate. Mites remain in the mating posture for about 30 minutes. In this process the male and female behave as that mentioned by Manglitz and Cory (1953) and Zaher *et al*., (1969a) concerning other tenuipalpid mites *Brevipalpus austvalis* (Tucker) (= *B. califovnicus* [Banks]) and *Cenopdpus lanceolatisetae* (Attiah), respectively.

Duration of developmental stages:

Incubation period:

Females usually deposit their eggs singly in preferable places such as depressions or near leaflet veins and as a result these eggs appear in groups. The ovoid egg is oval and dark red. The freshly laid egg is attached to the leaf surface. The egg turns opaque white before hatching. The egg stage lasted (18.20, 13.23) days at 25 °C and (16.48, 12.18) days at 30 °C, for female and male, respectively. The incubation period proceeds the egg becomes pale and just before hatching a split encircles it near the top, then the hatching larva pushes this part of the egg shell to crawl outside. The egg of the latter is spherical. Before hatching it turns to reddish pink and a split surrounds most of the egg from which the larva crawls outside leaving the egg shell. The description of eggs and hatching resemble results agreement with Zaher *et al*., (1969).

Immature stages:

Both male and female of *P. gawadii* pass through four active developmental stages before reaching adult (one larval and three nymphal stages, each active stage is followed by quiescent one). The average duration of all immature stages were (48.13 & 36.83) days for female and (39.98 & 25.03) for male at 25 and 30°C, respectively (Table 1).

Larval stage:

The newly hatched larva is dark red, nearly rounded and has three pairs of legs. Data in Table (1) revealed that the active larva typically fed for (9.20 & 7.90) days at 25°C and (7.55 & 4.48) days at 30 °C for females and males, respectively.

Larva becomes quiescent for (3.13 & 2.78) days at 25 °C and (2.27 & 1.80) days at 30°C, for female and male, respectively, before moulting to the protonymphal stage. The larval stage of *P. aegyptiacus* was 5.7 days at 25 °C according to Zaher *et al*., (1969b).

Protonymphal stage:

The reddish protonymph emerges with four pairs of legs and feeds. The duration of protonymphal stage of *P. gawadii* were (11.40 & 9.13) days at 25°C and (9.75 & 6.50) days at 30 °C, for female and male, respectively. The quiescent phase was (2.83 & 2.70) days at 25°C and (1.98& 1.78) days at 30 °C, for female and male, respectively (Table 1). In the end of this stage, the female protonymph has an ovoid body with a rounded posterior but the male protonymph has a pointed posterior and a nearly triangular body.

Deutonymphal stage:

Deutonymph is larger than protonymph but resemble protonymph with regard to feeding and other habits. The active deutonymph of *P. gawadii* was (8.50 & 6.65) days at 25°C and (6.50 & 4.08) days at 30°C for female and male, respectively, and the subsequent quiescent stage recorded (3.68 & 3.30) days at 25°C and (2.50 & 2.50) days at 30°C, for female and male, respectively (Table 1).

Tritonymphal stage:

Tritonymph is larger than deutonymph but resemble deutonymph with regard to feeding and other habits. The tritonymphal stage of *P. gawadii* was recorded for the first time. The active tritonymph survived (6.50 & 5.38) days at 25 °C and (4.73 & 2.63) days at 30 °C for female and male, respectively. The subsequent quiescent stage recorded (2.90 & 2.15) days at 20°C, (2.10 & 1.78) days at 25°C and (1.55 & 1.28) days at 30°C, respectively, (Table 1).

Table (1): Mean developmental times (in days) of *P. gawadii* females and males reared on date palm leaves at 25, 30 °C and 65 % R.H.

Parameter	Sex		Temperature (°C)	
			25	30
Egg	♀		18.20[a]±0.62	13.23[b]±0.52
	♂		16.48[a]±0.84	12.18[b]±0.55
Larval	♀	A	9.20[a]±0.78	7.55[b]±0.59
		Q	3.13[a]±0.48	2.27[c]±0.22
	♂	A	7.90[a]±0.57	4.48[b]±0.36
		Q	2.78[a]±0.36	1.80[b]±0.23
Protonymph	♀	A	11.40[a]±0.69	9.75[b]±0.72
		Q	2.83[a]±0.24	1.98[b]±0.28
	♂	A	9.13[a]±0.68	6.50[b]±0.35
		Q	2.70[a]±0.28	1.78[b]±0.22
Deutonymph	♀	A	8.50[a]±0.41	6.50[b]±0.46
		Q	3.68[a]±0.47	2.50[b]±0.0
	♂	A	6.65[a]±0.91	4.08[b]±0.41
		Q	3.30[a]±0.44	2.50[b]±0.0
Tritonymph	♀	A	6.50[a]±0.41	4.73[b]±0.49
		Q	2.90[a]±0.38	1.55[b]±0.28
	♂	A	5.38[a]±0.49	2.63[b]±0.32
		Q	2.15[a]±0.39	1.28[b]±0.25
Immature stages	♀		48.13[a]±1.68	36.83[b]±1.14
	♂		39.98[a]±1.96	25.03[b]±0.63
Life cycle	♀		66.33[a]±2.03	50.05[b]±1.45
	♂		56.45[a]±1.91	37.20[b]±0.86
Longevity	♀		78.23[a]±1.97	65.58[b]±1.41
	♂		68.60[a]±2.22	48.40[b]±0.97
Life span	♀		144.55[a]±3.12	115.63[b]±1.78
	♂		125.05[a]±3.58	85.60 [b]±1.16

A= Active stage, Q.= quiescent stage
Means±SE in each row followed by the same letter are not significantly different (P>0.05)

Life cycle:

The life cycle (from egg to adult) required 66.33 days at 25°C and 50.05 days at 30°C for female while it recorded 56.45 days at 25°C and 37.20 days at 30°C for male, respectively (Table,1). Zaher *et al*., (1969b) mentioned that the duration of life cycle was 26.4 days for female and 24.8 days for male of *P. aegyptiacus* at 26.9 °C and 52.7 % R.H.

Longevity of *P. gawadii*:

The pre-oviposition period averaged 19.23 and 14.85 days at 25 and 30 °C, respectively (Table 2). Zaher *et al*. (1969b) revealed that the pre-ovipostion period of *P. aegyptiacus* was 4.5 days at 28.3 °C, and the generation period was 30.09 days at 27°C.

The longevity lasted (78.23 & 68.60) days at 25°C and (65.58 & 48.40) days at 30°C for female and male, respectively, The mean generation time of female was 85.56 and 64.90 days at 25 and 30°C, respectively. The female laid an average of 46.8 and 96.5 eggs at 25 and 30°C, respectively, (Table 2). Adults lived (78.23 and 68.60) days at 25°C and (65.58 & 48.40) days at 30°C for female and male, respectively, while its lifespan averaged (144.55 & 125.05) days at 25°C and (115.63 & 85.60) days, at 25 and 30 °C, for female and male, respectively

Table (2): Pre-oviposition, Oviposition, Post-oviposition and fecundity of *P. gawadii* females at 25, 30°C and 65 % R.H.

Parameter	Temperature (°C)	
	25	30
Mean generation time (T) (in days)	85.56[a]±1.8	64.90[a]±1.55
Pre-oviposition period (in days)	19.23[a] ±0.69	14.85[b]±0.95
Oviposition period (in days)	30.2[a]±1.32	25[b]±0.67
Post-oviposition (in days)	28.8[a]±1.03	24.1[b]±1.2
Mean total fecundity (egg/♀)	46.8[a]±3.36	96.5[b]±2.27
Daily rate (egg/♀/day)	1.55[b]±0.14	3.86[a]±0.11

Means ±SE in each row followed by the same letter are not significantly different (P>0.05)

Life table parameters:

The calculated life table parameters considered were: net reproductive rate (R_0), doubling time (DT), intrinsic rate of natural increase (r_m), finite rate of increase (λ), gross reproductive rate (GRR) and cohort generation time (T_c).

The cohort generation time (T) of *P. gawadii* was affected by temperature degrees (Table 3). Its life table parameters were as follow, cohort generation time as (78.59 and 60.19 days); net reproductive rate (R_0) (21.24 and 44.01) per generation; intrinsic rate of natural increase (r_m) as (0.0389 and 0.0629); finite rate of increase (λ) averaged (1.039 and 1.065) and gross reproductive rate (GRR) (27.07 and 61.22) and doubling time (DT) values (17.8 and 11.1) days for females were reared on different temperatures. The 50% mortality of *P. gawadii* occurrence was short as 74 days at 30°C, while the longest was 93 days at 25 °C. These results agreed with that of Mesbah (2014) who showed that life table parameters of *R. indica* on leaves of date palm, where the highest intrinsic rate of natural increase (r_m) reached 0.149 at 20°C, respectively. This range of temperature was considered as the optimal range for *R. indica* . Whereas, lower (r_m) value as 0.115 was obtained at 15°C. While, time for population doubling was 6.05, 4.65 and 4.83 at 15, 20 and 25°C, respectively.

It can be concluded that temperature had effected on duration of each stage where, increasing temperature enhanced the development, fecundity and shortened the period of generation, life cycle, longevity and life span of *P. gawadii* .

Table (3): Life table parameters of *P. gawadii* at different temperatures.

Parameter	Temperature (°C)	
	25°C	**30°C**
Cohort generation time (T_c) [a]	78.59	60.19
Net reproductive rate (R_o) [b]	21.24	44.01
Intrinsic rate of increase (r_m) [c]	0.0389	0.0629
Finite rate of increase (λ)	1.039	1.065
Gross reproduction rate (GRR)	27.07	61.22
Doubling time (DT) [a]	17.8	11.1
50% mortality [a]	93	74

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

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دراسات بيولوجية و جداول الحياة للحلم *Phyllotetranychus gawadii* عند تربيتة علي درجتي حرارة

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أجريت دراسة بيولوجية للحلم *Phyllotetranychus gawadii* لدراسة تطورة و مدة بقائة و جداول الحياة عند تغذيتة علي سعف نخيل البلح علي درجتي ٢٥ و ٣٠ درجة مئوية و رطوبة نسبية ٦٥ %. و أظهرت النتائج و جود ثلاث أطوار للحورية قبل الوصول لطور البلوغ و قد تم تسجيل طور الحورية الثالثة لأول مرة لجنس *Phyllotetranychus*. و أوضحت النتائج أن أقصرة فترة حضانة و أطوار غير كاملة و مدة عمر الفرد بلغت ١٣.٢٣ و ٣٦.٨٣ و ٦٥.٨٣ يوم للأنثي ، ١٢.١٨ و ٢٥.٠٣ و ٤٨.٤٠ يوم للذكر، عند درجة حرارة ٣٠ مئوية ، كما أدت هذه الدرجة للحصول أعلي معدل زيادة طبيعي (r_m) بلغ ٠.٠٦٢٩ فرد/أنثي/يوم و أعلي معدل تكاثر (R_0) بلغ ٤٤.٠١ فرد/جيل. و سجل أعلي عدد من البيض تضعة الأنثي خلال حياتها و بلغ (٩٦.٥) بيضة بمعدل يومي بلغ ٣.٨٦ بيضة / أنثي/ يوم.