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BIOLOGY OF *AMBLYSEIUS GOSSIPI* ELBADRY (ACARI: PHYTOSEIIDAE) LIFE TABLES AND FEEDING BEHAVIOR ON DIFFERENT FOOD AND TEMPERATURES

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ABSTRACT

Biological characters and life table parameters of *Amblyseius gossipi* Elbadry were determined at three different kind of food. Duration of immature stages of *A. gossipi* were nearly similar when fed on different diets. Development % was significantly affected by the kind food where it was highly 90% when predatory mite fed on the animal prey, *Tetranychus urticae* Koch followed by its feeding on date palm pollens, 76% and Maize pollen, 72%.Longevity and fecundity of *A.gossipi* when feed on different food Date palm pollens and Maize pollens were successful alternative diet compared with live prey, *T. urticae*.Net reproductive rate (R_o) differed according to different food, these values averaged 21.54, 15.33 and 6.32 times for *T. urticae,* Date palm pollens and Maize pollens. The intrinsic rate of increase (r_m) was .31, 0.14 and 0.10 individual/♀/dayfor the above same order. The mean generation time (T) was decreased on Maize pollen.The daily rate of *T. urticae* consumption increased with increasing prey density to a maximum average of about 5.31 / individual/day at prey density of 15 / leaf disc compared with10 and 5 / leaf disc. The effect of temperatures on life cycle, developmental rate and survival immature % of *A. gossipi* fed on *T. urticae* was significant. Longevity was the longest at 25ºC compared with 20 and 30ºC where these values were 28.72 and 36.80 days for male and female, respectively. Female of *A. gossipi* laid 48.18 eggs at 30ºC, 35.88 eggs at 25ºC and 24.60 eggs at 20ºC. Temperature had significant differences with prey consumed where, *A. gossipi* consumed high number of prey when fed on *T. urticae* at 30ºC for male and female. The mean generation time (T) was decreased when the temperature increased, the net reproductive rate (R_o) value were 8.21, 16.36 and 23.15 times for 20, 25 and 30ºC respectively. The intrinsic rate of increase (r_m) were 0.11, 0.13 and 0.23 individual/♀/day for the above same order.

***Keywords*:** Biological aspects, *Amblyseius gossipi*, pollen, *T. urticae*, temperature

Introduction

Predaceous mites play an important role in the biological control of associated pests, such as phytophagous mites, scale insects and whiteflies. The most important natural enemies of tetranychid mites are phytoseiid mites (McMurtry and Croft 1997). Phytoseiid mites are important biological control agents because of their well-known capacity to suppress pest mite populations, mainly tetranychids in diverse cropping system (Easterbrook *et al.* 2001; Colfer *et al*., 2004). Members of the family phytoseiidae proved to be the most important due to their high predaceous efficiency, worldwide distribution and large number of species which exceeds 1700 species (Walter, 1992). The predatory mite of genus, *Amblyseius* attacks mites, including the two-spotted spider mite. *Amblyseius* is well adapted to hot and dry conditions, and is resistant to or tolerant of many organophosphate insecticides. Some are important in controlling phytophagous mites. *A. gossipi* is considered one of the species belonging to family phytoseiidae. The aim of the present study was to evaluate the effects of different kind food and the different temperatures on some biological aspects and life table parameters of *A. gossipi* that has a high ability to spread and highly predation in the studied area.

Materials and Methods

Stock culture of *Tetranychus urticae* Koch

The stock culture started with females collected from egg plantfrom a farm in Sharkia Governorate. The eggplant leaves (*Solanum melongena*) infested by the two-spotted spider mites, *T. urticae* were collected and placed in paper bags. Samples were transferred immediately to the laboratory. The mass culture was initiated by transferred individuals of females and males using a camel's hair brush placed in petri-dishes about10 cm diameter, which provided with untreated fresh leaves discs of mulberry (*Morus alba* L.) for *T. urticae* about 3 cm diameter placed on a pad of cotton wool, fully saturated with water as a source of moisture and to prevent mite escaping. Newly laid eggs were obtained by releasing the adult females on fresh and clean mulberry leaf discs overnight and removing all the adult females at the next day. After eggs hatching, the newly larvae were placed on fresh leaf discs in prepared petri-dished as mentioned above. The old leaf discs were removed after one day and mites were fed on fresh leaf discs. The colony was kept in an incubator at 27± 2°C and 65± 5% R.H.

Rearing of the predatory mite; *Amblyseius gossipi* Elbadry

A stock culture of the predatory mite; *A. gossipi* was collected from Soybean crops at Sharkia Governorate. Leaf discs 3 cm diameter of mulberry (*Mours alba* L.) were used as a substrate for rearing the predator and putted in Petri-dishes on piece of cotton wool, each disc was lined with a wet cotton barrier. Drops of water were added daily to maintain suitable moisture for the predator. Whenever, leaf substrate began to deteriorate, it was changed by fresh one and sufficient numbers of *T.urticae* at different stages were offered as prey. The experiments were carried out under constant conditions 27±2ºC and 65 ± 5 % R.H.

Effect of food type on some biological aspects of predacious mite:

Feeding on different diets:

The laboratory stock culture of predacious mite, *A. gossipi* used in the present study and reared on different diets at 27 ± 2ºC and 65 ± 5% R.H.

Diets:

Three diets were evaluated for their effect on development, survival, oviposition and life table parameter.

1- Animal:

T. urticae obtained from a laboratory colony reared under the same conditions as the predator. *T. urticae* was presented to predacious mites as immatures.

2- Pollen:

Two kinds of pollen were tested for their acceptability to predacious mites.

a) Date palm (*Phoenix dactylifera*) pollen.

b) Sweet corn (*Zea mays*) pollen.t

Bioassay testes:

Feeding *Amblyseius gossipi* on different kind food

The arenas used in this study were fabricated from (3 × 3 cm.) of mulberry leaf discs placed with upper surface down on a water- saturated sponge pad. A strip of moistened absorbent cotton was placed around the out side edge of the leaves. Single newly hatched larvae were placed on individual arenas supplied with the food resource to be evaluated. Arenas were examined daily and predator development and survival was recorded. Freshly collected pollen was made available to the predator by providing each arena with a small amount of test pollen and was replaced at 48-72 intervals. The pollen must store well and preferably have a low water content to minimize molding when used as a food source for mite rearing. Prey tetranychid mites consumed were replaced daily by fresh ones.

Newly emerged female, mated, confined individually on test arenas, along with food to be tested. Apiece of leaf (1 × 1 cm.) placed on the big veins of each leaf (arena), provided the leaf. Duration of immature stags, longevity and fecundity were recorded.

Every experiment was repeated twice and all were conducted under laboratory conditions at 27 ± 3ºC and 65 ± 5 % R.H.

Effect of prey density on egg laying, longevity and feeding behavior of *Amblyseius gossipi*:

Stock laboratory cultures of the predatory mite species, *A. gossipi* were separately maintained on mulberry leaves with the tetranychide mite *T. urticae* (Basha *et al*., 2007). Mature virgin females and newly emerged males of the four-species (which were within 24 - 48h after the final molt) were copulated and given sufficient time to mate on mulberry leaves with abundant preys. The experiments were conducted on upside down mulberry leaf discs of 4cm in diameter on water saturated cotton wool pads in open Petri- dishes and bordered with wet strip of cotton wool. Adult females of *T. urticae* were used as prey with three different densities 5, 10 and 15 per leaf disc. Newly mated females of each species (as previously described) were transferred to each leaf disc through three experimental series with 15 - 20 replicates individually of each prey density leaf discs were examined daily and the number of consumed preys and deposited eggs per two females were registered. All the killed preys were removed and replaced with another alive one. The experiments were carried out under laboratory conditions of 27 ± 2ºC and 65 ± 5% R.H. Data were subjected to statistical analysis using F. test according to (Sendecor 1966) methods using so ft ware costat programme.

Effect of temperature on predaceous mite *Amblyseius gossipi*:

To determine the effect of temperature on survival, development and fecundity of predacious mite, *A.gossipi*. The mated females were transferred from the established culture to leaf mulberry discs to lay eggs. The newly deposited eggs were transferred singly to another leaf mulberry disc of one inch in diameter as rearing arenas in Petri-dishes on water saturated cotton and kept on 30, 25 and 20ºC until hatched and incubation period was recorded. Each newly hatched larva (20 replicate) each replicate contain 1 larva which supplied with sufficient known number of the prey (immature of *T. urticae).* All larvae were reared individually under different temperatures, 30, 25 and 20ºC till reached adulthood duration of larvae and nymphal stage were calculated. Before the final molt of the female, one adult male was introduced into the replicate for mating. After a day, the male was removed and the female was observed at 6-12h intervals (same as egg- laying periods) to record the first oviposition date to measure fecundity, only three temperatures (20, 25 and 30ºC) were examined. The number of eggs laid was counted daily and consumption rate until female died. Longevity and consumption of adult male was recorded

Life table parameters

Life table parameters were collected using a BASIC computer program (Abou-Setta *et al*., 1986) for females reared on various tested temperature degrees. The following population growth parameters were determined: the mean generation time (T), the net reproductive increase (R_0), the intrinsic rate of increase (r_m) and the expected rate of increase (λ). During developmental period, eggs of resultant females were collected daily from each female and sex ratio of the progeny was determined.

Statistical analysis

Data were subjected to statistical analysis using one way analysis of variance, ANOVA (Duncan 1955).

Results and Discussion

Effect of food kind on some biological aspects of the predacious mite, *Amblyseius gossipi*

Predacious mites were able to develop maturity and reproduction, respectively, utilizing a wide range of food substances under laboratory conditions. Cannibalism phenomenon was observed when food was scarce in *A.gossipi*. Mating was essential for egg laying and occurred as early as the few hours after maturity. Females mated more than once. Multiple mating was necessary for females to lay their full complement of eggs.

Successful development from larvae to adult in *A.gossipi* occurred on the tetranychid mite, date palm and maize grain pollen supplied as food Table (1) the duration of immature stages were nearly similar when fed on different diets. Mortality was high with maize grain pollen and life cycle was shorter for male compared with female where it was (5.98 & 6.66 days) (7.50 & 7.54 days) and (9.8&9.9days) for male and female respectively when feed on *T. urticae*, Date palm pollens and Maize pollen respectively. Survival % was higher in female stage compared with male in all different food. The Development % was highly on feeding on the live prey (*T. urticae*) 90% followed by date palm pollens 76% and maize pollen 72%. (Awad *et al.*, 2001) revealed that *Euseins finlandicus* response to rearing on different food sources. Fecundity was the highest when fed on *Tulip* pollen and the lowest when fed on *T. urticae*, while total developmental time of immature stages was shortest on animal diet followed by pollen diet.

Table 1 : Duration in days of developmental stages and survival % of *Amblyseiu gossipi* on different food at 27 ± 2˚C and 65 ± 5% R.H.

Food	Sex	Development duration in days (mean ±S.E)					Life cycle	Survival %	Development %
		Egg	Larva	Proto-Nymph	Deuto-Nymph	Total immature			
T. urticae	♀	2.36±0.02	0.6±0.01	2.3±0.05	1.4±0.04	4.3±0.03	6.66±0.08 b	80.00	90.00
	♂	2.14±0.01	0.64±0.00	1.7±0.03	150±0.02	3.84±0.07	5.98±0.09 c	70.00	
Date palm pollens	♀	2.62±0.03	0.81±0.01	2.50±0.06	1.62±1.09	4.92±0.05	7.54±0.04b	72.72	76.00
	♂	2.33±0.04	0.91±0.02	1.72±0.04	2.6±1.11	5.23±0.04	7.56±0.03b	68..75	
Maize pollen	♀	3.66±0.17	0.92±0.03	2.44±0.09	2.88±1.38	6.24±0.05	9.9±1.69a	69.23	72.00
	♂	3.09±0.25	1.16±0.05	2.33±0.57	2.50±1.13	5.99±0.13	9.08±1.46a	60.00	

Means in columns followed by the same letter are not significantly different at p≤5%
± Standard Error

Data in Table (2) Showed that, the longevity and fecundity of *A.gossipi* when feed on different food Date palm pollens and Maize pollens were successful alternative diet compared with live prey, *T. urticae*. The pre-oviposition period of Adult female *A. gossipi* likewise was similar on animal and pollen where it was 1.55, 1,6 and 1.94 days for *T. urticae* , Date palm pollens and Maize pollens, respectively. The oviposition period was 15.2 and 13.3 days for feeding on *T. urticae* and Date palm pollens, respectively while it was decreased for feeding on Maize pollens 8.76 days. There was significant differences between different food on the longevity of predatory mite where it was decreased longevity appeared on Maize pollens. Female laid few numbers of eggs when fed on maize pollen 33.05 eggs while females fed on Tetranychid mite laid the highest number of eggs which was 41 eggs. (El-Laithy and El-Sawi, 1998) who studied the biology of predatory mite *Neoseiulusca lifornicus* fed on different pollen. Date palm pollen was preferable

Table 2 : Longevity and fecundity of *Amblyseius gossipi* on different food at 27 ± 2˚Cand 65 ± 5% R.H.

Biological aspects	Food		
	T. urticae	**Date palm pollens**	**Maize pollen**
Pre-oviposition	1.55±0.12	1.6±0.14	1.94±0.19
Oviposition	15.2±1.39	13.3±1.35	8.76±1.1
Post-oviposition	3.6±0.91	3.1±0.77	2.11±0.2
Longevity(in days)	20.35±2.03a	18±1.66b	12.81±1.18c
Fecundity	41.00±4.25a	38.35±3.50a	33.05±2.73b

Means in rows followed by the same letter are not significantly different at p≤5%
± Standard Error

Concerning life table parameters of *A. gossipi* indicated that thermal factor has a great influence in Table (3). Life span of *A. gossipi* ranged from 22.71 to 27.01 days when feed on Maize pollen and *T. urticae*. Net reproductive rate (R_o) differed according to different food, these values averaged 21.54, 15.33 and 6.32 times for *T. urticae,* Date palm pollens and Maize pollens. The intrinsic rate of increase (r_m) were0.31, 0.14 and 0.10 individual/♀/day for the above same order. The mean generation time (T) was decreased on Maize pollen. Similar results were also obtained by (Puchalska and Kozak 2016) noticed that *Typhlodromus pyri* when fed on *Tetranychus urticae*, the net reproductive rate (R_0) value (11.50). Mean generation time (T) was (22.20). The intrinsic rate of population increase (r_m) was (0.11).Important information into pest management programs. These parameters, especially theintrinsic rate of increase (r_m,), are increasingly used as a means of selecting promising biocontrol candidates (Roy *et al.* 2003). Laboratory studies on development and reproduction. The pollen has a great nutritional quality for some arthropods especially due to high content of proteins and essential amino acids (Cook *et al.* 2003, Keller *et al.* 2005).

Table 3 : Effect of different foodon the life table parameters of *Amblyseius Gossipi* at 27 ± 2˚C and 65 ± 5% R.H

Food	Life span (in days)	R_o	T	r_m	Λ
T. urticae	27.01±2.50a	21.54	10.22	0.31	1.6
Date palm pollens	25.54±2.43a	15.33	14.65	0.14	1.15
Maize pollen	22.71±1.6b	6.32	21.60	0.10	1.11

Means in columns followed by the same letter are not significantly different at p≤5%
± Standard Error

Effect of prey densities on some biological aspects of predacious mites

Consumption, oviposition rates and longevity of predaceious mite, *A. gossipi,* reared on mulberry leaf discs under laboratory conditions, Table (4) Results showed that, the daily rate of *T. urticae* females consumption increased with increasing prey density to a maximum average of about 5.31 and 5.02 and 4.77prey/day / individual at prey density of 15, 10 and 5 per leaf disc respectively, for *A. gossipi*. The oviposition rate reached its maximum value 49.47 eggs at the highest prey density of 15 / leaf disc. On the other hand, at the lowest prey density of 5 / leaf disc this value decreased to 40.08 and 46.31 egg. For 5 and 10 prey density, it means that daily fecundity increased gradually in relation to the amount of prey consumed. Statistical analysis cleared that, longevity of predacious mites was significantly influenced by number of prey provided daily and longevity fluctuated on other predacious at 5, 10 and 15 prey density. The obtained result nearly similar to (Sharma and Sadana, 1987) who studied the effect of the prey densities on the predation rate and daily fecundity of the phytoseiid, *Amblyseius finlandicus* feeding on *Eutetranychus erientalis* in the laboratory at 27.3 – 30.5ºC, the number of prey consumed increased with increases in predator density at predator: prey ratios of 1 : 10 to 1 : 30 but then decreased with increases in predator density and (Greco *et al.,* 2005) found significant differences between consumption behavior of phytoseiid mite, *Neoseiulusca lifornicus* and prey densities of *T. urticae.*

Table 4 : Influence of three prey levels of *T. urticae* adult stage on the consumption, fecundity and longevity of Predaceious mite *Amblyseius gossipi* females at 27±2˚C and 65±5% R.H.

Prey densities	Consumption	Daily rate	Fecundity	Longevity (in days)	R_o	T	r_m	λ
5	103.92±3.60b	4.77	40.08±0.20b	21.76±0.23c	7.3	16.00	0.25	1.1
10	123.57±3.68a	5.02	46.31±0.10ab	24.57±0.30b	13.50	14.13	0.19	1.18
15	129.52±3.21a	5.31	49.47±0.08a	26.23±0.70a	21.57	10.25	0.14	1.14

- Means in columns followed by the same letter are not significantly different atp≤5% according to Duncan's multiple range test **(Duncan, 1955).**
± Standard Error

The effect of temperatures on life cycle, developmental rate and survival immature % of *A. gossipi* fed on *T. urticae* which supplied as prey. Represented in Table (5), Data showed that, 25 and 30ºC have no significant effect on life cycle duration but it was 12.80 days at 20ºC. 25ºC was optimum for rearing *A. gossipi;* survival immature % was 89.65% and 84.00% for female and male, respectively and developmental rate % was 78.34%.

Table 5 : Development time in days, survival of immature stages and lifecycle of *Amblyseius gossipi* on three different temperatures at 65±5% R.H.

Temp. (˚C)	Sex	Development duration in days(mean ±S.E)				Life cycle	Survival immature%	Development %
		Egg	Larva	Proto-nymph	Deuto-nymph			
30	♀	2.22±0.14	1.45±0.13	2.77±0.21	2.13±0.13	8.57±0.11**b**	78.57	78.21
	♂	2.22±0.22	1.36±0.26	1.63±0.12	1.86±0.14	7.07±0.40	81.48	73.34
25	♀	2.76±0.26	1.57±0.20	2.19±0.38	2.42±0.07	8.94±1.07**b**	89.65	75.39
	♂	2.72±0.23	1.44±0.17	1.88±0.16	2.16±0.04	8.20±0.90	84.00	78.34
20	♀	5.20±0.27	1.85±0.14	2.50±0.71	3.25±0.10	12.80±0.45**a**	71.42	61.19
	♂	4.88±0.24	1.76±0.23	2.35±0.04	2.88±0.26	11.87±0.71	70.37	65.00

- Means in columns followed by the same letter are not significantly different at p≤5% according to Duncan's multiple range test (Duncan, 1955).
± Standard Error

Concerning life table parameters of *A. gossipi* indicated that thermal factor has a great influence in **Table (6)** showed that, 25ºC was optimum for rearing of *A. gossipi* where longevity was the longest at 25ºC compared with 20 and 30ºC where this value was 28.72 and 36.80 days for male and female, respectively. Female of *A. gossipi* laid 48.18 eggs at 30ºC, 35.88 eggs at 25ºC and 24.60 eggs at 20ºC. Temperature had significant differences with prey consumed were *A.gossipi* consumed highly number of prey when fed on *T. urticae* at 30ºC for male and female were its values were 22.17, 43.05 and 78.54 prey for male and 40.60, 7088 and 110.31 prey for female at 20, 25 and 30ºC, respectively.Net reproductive rate (R_o) differed according to temperature as this values increased with temperature increased. Thus, these values averaged 8.21, 16.36 and 23.15 times for 20, 25 and 30 ºC. The intrinsic rate of increase (r_m) was 0.11, 0.13 and 0.23 individual/♀/day for the above same order.The mean generation time (T) was decreased when the temperature increased.

Table 6 : Effect of temperature on biology of the predatorymite *Amblyseius Gossipi* at 65±5% R.H.

Temp. (˚c)	Sex	Longevity	Consumption	Fecundity	R_o	T	r_m	λ
30	♂	23.31±0.44**b**	78.54±0.44**a**	-	-	-	-	-
	♀	32.13±0.19**b**	110.31±0.59**a**	48.18±1.86**a**	23.15	11.77	0.23	1.3
25	♂	28.72±0.51**a**	43.05±0.53**b**	-	-			
	♀	36.80±0.67**a**	70.88±0.34**b**	35.88±1.45**b**	16.36	12.50	0.13	1.27
20	♂	19.23±0.44**c**	22.17±0.41**c**	-				
	♀	28.35±0.76**c**	40.60±0.294**c**	24.60±1.19**c**	8.21	14.03	0.11	1.21

- Means in columns followed by the same letter are not significantly different at p≤5% according to Duncan's multiple range test (Duncan, 1955).
± Standard Error

Conclusion

Generally, the predatory mite, *Amblyseius gossipi* was feed successfully on different kinds of food, Date palm pollens and Maize pollens in addition to alive prey, *T. urticae*. The obtained results were good regarding with its longevity, fecundity and consumption. Prey densities effect significantly on the predator consumption and level 1:10 was the best density. The temperature 30°C was the best for the predator survival. So, the predator can feed on unlived prey then released on live prey at 1:10.

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