Egypt. J. Agric. Res., 79 (4), 2001.

LIFE TABLES AND FOOD RANGE OF *TYPHLODROMUS ATHIASAE* AT DIFFERENT TEMPERATURES (ACARI: PHYTOSEIIDAE)

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(Manuscript received September 2000)

Abstract

Life tables were constructed for the phytoseiid predatory mite *Typhlodromus athiasae* Porath and Swirski fed on the most suitable prey, immatures of the two-spotted spider mite *Tetranychus urticae* Koch, at different temperatures, 15, 20, 25, 28, 30 and 32 ºC, and 70% R.H. The intrinsic rate of increase (rm) reached its maximum value (0.237 individuals/female/day) at 30 ºC. *T.athiasae* was able to survive and reproduce on the two- spotted spider mite *T.urticae* (adults), the red spider mite *T.cucurbitacearum* (Sayed) (immatures), the citrus brown mite *Eutetranychus orientalis* (Klein) (immatures and adults), the mango leaf mite *Cisaberoptes kenyae* Keifer (active stages), the scale insect *Parlatoria zizyphus* (Lucas) (eggs), the whitefly *Bemisia tabaci* (Gennadius) (eggs) and the date palm *Phoenix dactylifera* L. pollen grains.

INTRODUCTION

Predaceous mites play a considerable role in the biological control of associated pests. Members of the family Phytoseiidae are the most important biological control agents due to their predaceous efficiency, world wide distribution and great numbers; the family includes more than 1700 species (Walter, 1992).

It is impossible to evaluate the biological control potential of a predator without knowing its feeding habits and general biology (Muma, 1969). Determing such parameters as rates of development, reproductive capacity and searching abilities should lead to a better understanding of a predator's potential and the possibility of predicting its biocontrol potential to suppress injurious mites populations below economic levels (Helle and Van de Vrie, 1974).

Typhlodromus athiasae Porath and Swirski (= *T.siwa* El-Badry, and = *T.pelargonicus* El-Badry, Chant and Yoshida-Shaul, 1987) is one of the most promising predaceous mites found on apple trees in newly reclaimed lands of the Egyptian North Western desert. Some scattered works were done on the biology and feeding habits of *T.athiasae* (Swirski *et al.*, 1967; Hessein, 1977; El-Banhawy and El-Bagoury, 1991). Therefore, this study was carried out to clarify the food range and determine the life table parameters of this predaceous mite at different temperatures and to throw some light on its importance as a biological control agent.

MATERIALS AND METHODS

Samples of *T.athiasae* were obtained from an apple orchard (*Malus sylvestris* Mill) variety Anna at El-Sadat City (a newly reclaimed area 60 Km. North west of Cairo, at Menofia Governorate). A culture of *T.athiasae* was reared on *Tetranychus urticae* Koch as prey on a mulberry leaf *Morus alba* L. situated upside down on cotton wool soaked in water on a 9 cm diameter Petri-dish. The edges of the leaf were also lined with a wet cotton barrier.

For testing the most suitable food, different associated prey types as well as date palm (*Phoenix dactylifera* L.) pollen grains were used to determine its suitability as a sole source of food for survival and reproduction. The prey included the two-spotted spider mite *Tetranychus urticae* Koch (immatures and adults), the red spider mite *T.cucurbitacearum* (Sayed) (immatures), the citrus brown mite *Eutetranychus orientalis* (Klein) (immatures and adults), the mango leaf mite *Cisaberoptes kenyae* Keifer (active stages), the scale insect *Parlatoria zizyphus* (Lucas) (eggs) and the whitefly *Bemisia tabaci* (Gennadius) (eggs). Newly emerged and copulated predator females (N=20) were confined singly together with each tested food on mulberry leaves at 25 ± 1 ºC and 70 ± 5% R.H. throughout their life span to find out the food which resulted in greatest fecundity.

To determine the effect of temperature on life parametery, newly deposited predator eggs (N=50) were confined singly on mulberry leaf discs 2 cm in diameter. Each hatched larva was supplied with fresh suitable food (*T.urticae* immatures). Experiments were conducted at 15, 20, 25, 28, 30, and 32 ºC at 70 ± 5% R.H. under 16 hours of cool white fluorescent light (21 umol / S^{-1} / m^{-2}) and 8 hours of darkness and observed daily.

Life table parameters of female were determined separately to obtain the means and indicate a source of variance for each parameter and the intrinsic rate of increase rm was calculated by using the life 48 computer program (Abou-Setta *et al.*, 1986). It is determined from the formula:

$$\sum_{o}^{\infty} \exp(-rm\ x)\ lx\ mx = 1$$

where mx is the number of daughters produced per female during the interval x and lx is the fraction of females alive at age x. The values rm and exp rm are obtained from the formula. The finite rate of increase, exp rm, is the natural antilogarithm of the intrinsic rate of increase and gives the number of times the population multiplies in a unit of time. The net reproduction rate (Ro) is the rate of multiplication in one generation. T is the mean length of generation time usually expressed in days. These definitions are by Birch (1948).

RESULTS AND DISCUSSION

Laboratory studies showed that mating is essential for egg deposition and females accepted copulation more than once. Cannibalism was observed as adults fed on their own eggs and immatures in the absence of food. Sabelis (1981) stated that if neither alternative food nor water sources are available, cannibalism can be expected in some phytoseids. Larva is not a feeding stage. Mc Murtry *et al.*, (1970) suggested that it may be advantageous for the species assuming that it has a low searching ability.

Food range/Adult females of *T.athiasae* survived and oviposited when fed on all tested foods, but at different rates. Statistical analysis, Table 1 showed those different kinds of food significantly affected female fecundity. Immatures of *T.urticae* were the most suitable food for fecundity being the mean/female and daily rate during the 1st 15 days of oviposition, 26.40 and 1.76 eggs. Immatures of *E.orientalis* ranked the second (23.42 and 1.56 eggs), while eggs of whitefly *B.tabaci* came in the last (3.74 and 0.74 eggs).

The webbing produced by *T.urticae* did not affect *T.athiasae*. The characteristic of long dorsal and lateral setae seems to be associated with "highly effective" species specialized in tetranychid predation and capable of developing in dense webbing of prey species (Mc Murtry, 1982). Sabelis (1981) suggested that these setae serve as a wedge in the sticky web during forward locomotion of *P.persimilis* and *A.bibens*.

Influence of temperature on developmental time: The temperature was negatively related with the duration of every female developmental stage and consequently with the whole immature period. The female life cycle (egg deposition – adult emergence) averaged 25.00, 13.00, 8.50, 7.50, 6.75 and 6.31 days at 15, 20, 25, 28, 30 and 32 ºC, when fed on *T.urticae* immatures (the most suitable prey), respectively, Table 2. Statistical analysis showed that significant differences were found between life cycle duration's at 15, 20, 25, 28, and (30 & 32 ºC), while no significant differences were found between 30, and 32 ºC. Male followed similar trend, but having shorter periods, Table 2. Sabelis (1985) stated that the rate of egg to adult development in phytoseiids generally increases in a linear fashion between 15 and 30 ºC.

The sex ratio (females / total) changed according to the change of temperature. Percent of females of *T.athiasae* increased from 54% at 15 ºC to 65% at 30 ºC, then decreased to 56% at 32 ºC, Table 4. This indicated that 30 ºC was the most suitable degree for giving higher female sex ratio, which consequently resulted in reproduction increase. Adult female longevity was negatively affected by temperature. On the contrary, temperature positively affected female fecundity. The greatest number of deposited eggs per female occurred at 28 ºC (47.13 eggs), with a daily rate 1.56 eggs, while the smallest number occurred at 15 ºC (17.00 eggs) with a daily rate 0.33 eggs.

Statistical analysis showed that temperature significantly affected the adult longevity, while no significant differences were found between 30 and 32 ºC. Concerning adult fecundity, significant differences were found between experimented temperature degrees except between 25 and 28 ºC, Table 3.

Many investigations have been conducted on development of phytoseiid mites at different temperature degrees. Usually, developmental time decreases with increasing temperature till reaching a certain fovourite degree (Mc Murtry *et al.*, 1970; De Moraes and Mc Murtry, 1981; Ferragut *et al.*, 1987; Caceres and Childers, 1991).

The effect of temperature on life table parameters of *T.athiasae* fed on *T.urticae* immatures is shown in Table 4 and Fig. 1. The multiplication per generation (Ro) differed according to temperature as these values increased with temperature increase till reaching 30 ºC (73.95 times) in a generation time (T) of 13.38 days, then began to decrease at 32 ºC (31.96 times). The highest rm (0.237 individual/female/day) was obtained at 30 ºC despite decreases in survival and reproduction later in life and had a finite rate of natural increase (exp rm) of 0.224 times/female/day.

The age specific female fecundity (Mx) and the rate of survival (Lx) are shown in Fig. 1. Although the rate of female survival (Lx) was less at 30 ºC than at 32 ºC, yet specific rate of fecundity (Mx) was higher and greatly affected the intrinsic rate of increase. Similar rm values were reported for *Amblyseius deleoni* Muma and Denmark

(Saito and Mori, 1981), *A.chilenensis* (Dosse) at 25 ºC (Ma and Laing, 1973), and *Galendromus helveolus* (Chant) at 30 ºC (Caceres and Childers, 1991).

It may be concluded that, when reared on immatures of the two-spotted spider mite *T.urticae*, the predator *T.athiasae* achieves its highest population potential at 30 ºC.

Thus, this phytoseiid species could be considered a promising species as a bio-control agent of the red spider mites in Egypt.

Table 1. Fecundity of *T.athiasae* females fed on different foods at 25 ºC and 70% R.H. during the first 15 days of oviposition.

Prey	No. of eggs / female			
	N	Mean	SD	Daily rate
Tetranychus urticae immatures	20	26.40	0.20	1.76
T.urticae adults	20	18.59	0.21	1.24
T.cucurbitacearum immatures	20	20.60	0.16	1.37
Eutetranychus orientalis immatures	20	23.42	0.19	1.56
E.orientalis adults	20	12.18	0.16	0.78
Cisaberoptus kenyae active stages	20	14.34	0.19	0.97
Parlatoria zizyphus eggs	20	7.87	0.05	0.53
Bemisia tabaci eggs	20	3.74	0.32	0.74
Date palm pollen	20	10.23	0.10	0.69

LSD 0.05:

Mean = 1.89

Table 2. Duration in days of different stages of *T.athiasae* fed on immatures of *T.urticae* at different temperatures and 70% R.H.

Temp. °C	Female			Male		
	N	Mean	SD	N	Mean	SD
			Egg			
15	27	7.13	0.99	23	6.86	0.90
20	29	3.73	0.71	21	3.42	0.53
25	30	2.60	0.52	18	2.29	0.49
28	32	2.13	0.35	17	2.04	0.18
30	33	2.01	0.05	15	2.03	0.21
32	27	2.03	0.04	21	2.06	0.11
			Larva			
15	27	2.63	0.74	23	2.57	0.53
20	29	1.63	0.52	21	1.29	0.49
25	30	1.01	0.11	18	1.03	0.10
28	32	0.88	0.23	17	0.83	0.26
30	33	0.75	0.26	15	0.67	0.26
32	27	0.69	0.24	21	0.50	0.11
			Protonymph			
15	27	7.50	1.41	23	6.71	0.95
20	29	4.01	0.93	21	3.43	0.89
25	30	2.40	0.52	18	2.29	0.49
28	32	2.13	0.35	17	2.04	0.26
30	33	1.80	0.42	15	1.50	0.55
32	27	1.63	0.52	21	1.51	0.55
			Deutonymph			
15	27	7.75	0.71	23	6.86	0.69
20	29	3.63	0.74	21	3.29	0.49
25	30	2.50	0.53	18	2.14	0.38
28	32	2.38	0.52	17	2.17	0.41
30	33	2.20	0.42	15	2.05	0.28
32	27	2.03	0.17	21	1.83	0.41

Table 3. Effect of different temperatures on immature and adult longevity and fecundity of *T.athiasae* females when fed on *T.urticae* immatures at 70% R.H.

Temp. °C	Average duration in days*					No. eggs / female	
	Immature (egg to adult)	Pre – ovi-position	Ovi-position	Post – ovi-position	Longevity	Total average*	Daily rate
15	25.00 ± 1.31	8.13 ± 1.46	52.25 ± 3.77	23.88 ± 3.04	84.25 ± 5.06	17.00 ± 2.33	0.33
20	13.00 ± 1.77	4.63 ± 0.92	42.28 ± 2.70	18.25 ± 1.67	65.75 ± 2.12	39.63 ± 3.34	0.92
25	8.50 ± 0.53	3.00 ± 0.18	33.10 ± 3.41	12.50 ± 0.97	48.60 ± 3.03	46.30 ± 3.23	1.39
28	7.50 ± 0.60	2.25 ± 0.46	30.25 ± 2.25	7.38 ± 1.51	39.88 ± 3.00	47.13 ± 2.13	1.56
30	6.75 ± 0.26	1.50 ± 0.53	21.50 ± 1.51	5.50 ± 1.18	28.50 ± 2.51	44.90 ± 2.90	2.09
32	6.31 ± 0.59	1.50 ± 0.52	21.25 ± 1.39	4.50 ± 0.93	27.25 ± 1.04	34.50 ± 4.50	1.62

LSD 0.05:

* Mean ± SD

Immature = 0.76
Adult longevity = 2.46
Total eggs = 2.51

Table 4. Effect of different temperatures on life table parameters of *T.athiasae* when fed on *T.urticae* immatures at 70% R.H.

Parameter	Temperature, °C					
	15	20	25	28	30	32
Net reproductive rate (Ro)	6.46	19.30	44.85	52.54	73.95	31.96
Generation time (days) (T)	46.68	25.84	17.25	15.76	13.38	12.87
Intrinsic rate of increase (rm)	0.040	0.114	0.186	0.203	0.237	0.224
Finite rate of increase (exp rm)	1.04	1.12	1.20	1.22	1.27	1.25
Sex ratio (females / total)	0.54	0.58	0.61	0.63	0.65	0.56

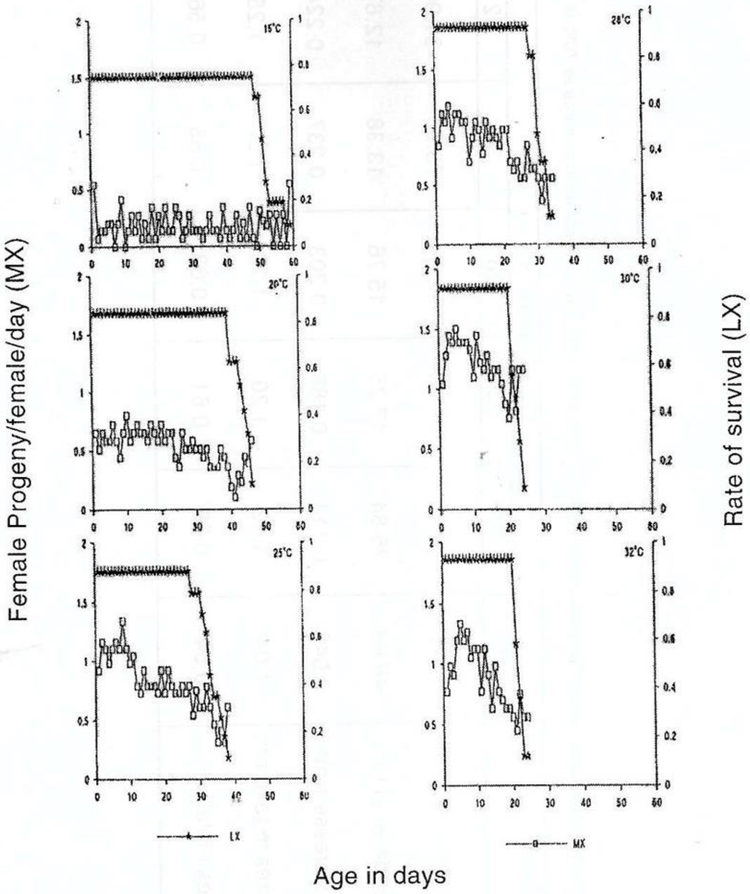

Fig. 1. Age-specific fecundity and survival of *T. athiasae* at different temperatures when fed on *T. urticae* immatures.

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جداول الحياة للنوع *Typhlodromus athiasae* علي درجات حرارة مختلفة

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تم حساب جداول الحياة للمفترس الأكاروسي *T.athiasae* و ذلك عند تغذيته علي الغذاء المفضل له و هو الأطوار غير الكاملة للعنكبوت الأحمر العادي ذي البقعتين النوع الأخضر *Tetranychus urticae* Koch علي درجات حرارة مختلفة ١٥، ٢٠، ٢٥، ٢٨، ٣٠ و٣٢°م ورطوبة نسبية ٧٠٪. ووجد أن معدل الزيادة الذاتي (rm) يصل إلى اعلي معدل له (٠,٢٣٧ فرد/ أنثى/ يوم) علي درجة حرارة ٣٠°م.

كما وجد أن هذا المفترس الأكاروسي يمكنه أن يعيش و يتكاثر علي الأطوار الكاملة للعنكبوت الأحمر العادي ذي البقعتين النوع الأخضر *T.urticae* وكذلك الأطوار غير الكاملة فقط من أكاروس العنكبوت الأحمر العادي النوع الأحمر *Tetranychus cucurbitacearum* (Sayed) والأطوار غير الكاملة و الكاملة لأكاروس الموالح البني *Eutetranychus orientalis* (Klein) والأطوار المتحركة لأكاروس أوراق المانجو الدودي *Cisaberoptes kenyae* Keifer وبيض الحشرة القشرية *Parlatoria zizyphus* (Lucas) وبيض الذبابة البيضاء *Bemisia tabaci* (Gennadius) وحبوب لقاح نخيل البلح *Phoenix dactylifera* L.