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Some Biological Aspects of The Mite *Typhlodromus malus* as A Predator of Spider Mite *Tetranychus urticae*

Hend Abdel-Aziz El-Nasharty*

Department of Plant Protection, Faculty of Agriculture, Zagazig University, Zagazig, Egypt

*Correspondance: drhendbasha@gmail.com

ABSTRACT

Life cycle, reproduction, and prey consumption rate of the phytoseiid species *Typhlodromus malus* Basha & Yousef that are previously undetermined were studied when the mite fed on immature stages of the two spotted spider mite, *Tetranychus urticae* Koch, under laboratory conditions of $27\pm4^{\circ}\text{C}$ to estimate its role in the biological control of this acarine pest. The total period of the immature stages averaged 5.78 days for females and 4.73 days for males, during which they consumed 21.71 and 12.71 prey individuals, respectively. The adult female of *T. malus* proved to be the most effective as it devoured a greater number of prey than the male. The average generation period was 9.57 days. Adult female continued depositing eggs during a period of 12.14 days, where it fed on a total average of 159.28 prey individuals and laid a total average and daily mean of 19.86 and 1.56 eggs, respectively. Also, the prey stage preference of *T. malus* females at constant densities of different stages of *T. urticae* was discussed.

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INTRODUCTION

The two-spotted spider mite species *Tetranychus urticae* Koch (Acari: Tetranychidae) is among the major pests occurring on many agricultural crops in different parts of the world (Helle & Sabelis 1985a). Due to the increased use of agrochemicals in controlling this pest, pesticide resistance and environmental pollution have developed (Cranham & Helle 1985; Hussey & Scopes 1985). This fact, combined with pressure for the use of fewer pesticides, is leading to an increased use of predatory mites as control agents. Mites of the family Phytoseiidae are the best-known predators among the Acari, feeding on eggs, immatures, and adults of phytophagous mites and small insects that are agricultural pests (Gerson & Smiley 1990; Abden, *et al.*, 2021). Several phytoseiid species have attained commercial status and are currently being mass-reared and sold for biological control of spider mites (Helle & Sabelis, 1985b; McMurtry, 1992; McMurtry & Croft, 1997; Badii *et al.*, 1999; Naher *et al.*, 2005; Wimmer *et al.*, 2008; Goleva & Zebitz, 2013; Kumar *et al.*, 2015; Fonseca *et al.*, 2020).

In Egypt, the efficiency of several phytoseiids as biological control agents against some agricultural pests was investigated (Zaher, 1986; Fouly & El-laithy, 1992; El-Banhawy, *et al.*, 1997; Basha *et al.*, 2002; Nassar, *et al.*, 2010; Awad *et al.*, 2019; Filgueiras, *et al.*, 2020; Momen *et al.*, 2020; Vásquez *et al.*, 2023). The predatory mite *Typhlodromus malus* Basha & Yousef was described from Egypt, occurring on apple trees *Malus pumila* L. (Basha *et al.*, 2001). Field observations carried out by Basha *et al.*, (2007) showed that *T. malus* was found in association with several agricultural

pests attacking various host plants in different localities of Sharkia governorate, Egypt. Nothing is known about the biological aspects of this predatory mite. Therefore, the objective of the present work was to clarify the life cycle, reproduction and consumption rate of *T. malus* when fed on immature stages of the plant feeder mite *T. urticae* to establish its potential for the biological control of this acarine pest in Egypt.

MATERIALS AND METHODS

T. malus was collected from mulberry tree leaves (*Morus alba* L.) and the prey *T. urticae* from castor bean leaves (*Ricinus communis* L.) at Kom-hmada district, Beheira governorate, Egypt. Laboratory cultures of the prey and the predator were maintained for several generations on mulberry leaf arenas, placed underside down on water-saturated cotton pads in open petri-dishes to prevent desiccation of the leaf arenas (Razmjou *et al.*, 2009).

Each leaf arena was surrounded by a wet, narrow strip of cotton wool saturated with water to minimize the escape of mite individuals and to supply them with water (Castagnoli & Simoni, 1999).

Enough moisture in the cotton layer was maintained by adding a few drops of water if needed. When leaf arenas began to deteriorate, mite individuals were transferred to new ones (Pontier *et al.*, 2000). The predator *T. imalus* was reared according to the method described by Mostafa (2004). Leaf discs of mulberry, one inch in diameter each as previously prepared in the stock culture, were used as rearing substrate. A number of 25 mated females were individually isolated from the stock culture and placed singly on 25 replicated leaf

discs. Immediately after egg deposition, females were removed and transferred to the stock culture. The deposited eggs were examined twice a day during the incubation period. Hatched larvae were reared singly till reaching maturity. Emerged females were copulated and kept for oviposition. Rearing individuals were examined daily till all individuals died. Immatures and adults of the predator were supplied with a known number of *T. urticae* immature stages, and the devoured individuals were daily counted and replaced with a live one. Duration of developmental stages, reproduction, and number of consumed prey individuals were recorded during the predator's life span. The consumption rate and prey stage preference of the predatory mite *T. malus* were investigated according to Badii *et al.*, (2004). A total of 150 prey items, *i.e.*, an equal number (25) of newly emerged individual eggs, larvae, protonymphs, deutonymphs, adult females, and adult males of *T. urticae* were offered for a 24h period to a starved three-day-old mated female predator on 3x3cm mulberry leaf discs as previously prepared. Then, each predator female was allowed to feed on prey items for a total of 24h, and the number of prey individuals consumed per predator female per day was estimated. Each leaf arena was replicated 15 times. Experiments were carried out in the laboratory at $27\pm4^{\circ}\text{C}$ and $70\pm 5\%$ R.H. Data were subjected to statistical analysis using the F-test according to Snedecor (1966).

The aforementioned species in this study were defined by Prof. Dr. A. E. Basha, Professor of Agricultural Zoology.

RESULTS AND DISCUSSION

Behavior and life cycle stages

The phytoseiid species *T. malus* was usually found on vegetative parts of many field and horticultural crops, in association with various arthropod pests. Mite individuals are fast running and were noticed to attack the spider mite *T. urticae*. When the predator *T. malus* attacked an individual of the spider mite, the adult female held the prey by the palps and first pair of legs during predation and sucked out the whole-body content.

T. malus has four immature developmental stages before reaching adult characteristics of the members of the family Phytoseiidae: egg, larva, protonymph, and deutonymph. No mortality of immature stages was recorded when feeding on immature stages of the introduced prey.

Duration of developmental stages

Rearing *T. malus* was carried out in the laboratory with an average temperature of $27\pm4^{\circ}\text{C}$. The incubation period averaged 2.07 and 1.86 days for both females and males, respectively (Table 1). Duration of immature stages averaged 5.78 and 4.73

days for females and males, respectively. The female and male life cycle durations were an average of 7.86 and 6.78 days, respectively. Adult male longevity was shorter (8.28 days) than that of females, as it averaged 16.71 days. The time needed by the predator female to complete a generation (from egg to egg) in the laboratory was 9.57 days. As shown in Table 1, the total life span averaged 24.57 days for females, with about 9 days longer than for males (15.07 days).

Oviposition and Fecundity

Mating occurs soon after the adult female emerges. The female accepts more than one copulation, and the male can mate with more than one female. The predator eggs were singly laid on rearing arenas. Yet on some occasions, they might be noticed besides each other, showing clusters of 2-3 eggs. The time from maturation to the first egg (pre-oviposition period) was short (1.71 days). The female continued ovipositing eggs for a longer oviposition period (12.14 days) and laid 19.86 eggs as a total average, with a daily mean of 1.56 eggs (Table 2). Before *T. malus* female death, it stopped laying eggs for a period averaging 2.86 days (Table 1).

Predator efficiency

The total average and daily mean of *T. urticae* immature stages devoured by *T. malus* developmental stages are given in Table 1.

The larva of this predator does not feed, as it is sluggish during this stage. A distinct change in activity occurred after changing to protonymph, as it began to feed voraciously. The predator's feeding capacity increased with successive developmental stages (Table 1). Female proto and deutonymph fed on 4.86 and 16.86 prey individuals, respectively, with a total average, with a daily mean of 2.66 and 7.43 prey. Immature females consumed more prey (21.71) in total than males (12.71). Yousef (1981) mentioned that female immature stages of *Typhlodromus africanus* fed on about twice as much as that consumed by male immature stages. Abdallah *et al.* (2001) showed that immature female stages of *Euseius finlandicus* consumed more spider mite *T. urticae* larvae (11.85) in total than males (9.18).

During adulthood, the female predator proved to be the most effective as it devoured a greater number of prey (201.43) than the male (60.28). Fouly and El-laithy (1992) reported that adult females of *Amblyseius barkeri* consumed 94.25% of the total prey consumption throughout their life span. The greatest number of prey individuals consumed by *T. malus* females was recorded during the period of egg deposition (Table 2), as it devoured a total average of 159.28 prey individuals (about 71.38% of the total preys consumed during life span).

Table 1: Duration (in days) and prey consumption of *Typhlodromus malus* when fed on immatures of *Tetranychus urticae* at 27±4°C.

Stages	Duration (days)		Consumed prey individuals			
	Female	male	Female		male	
			Total average	Daily mean	Total average	Daily mean
Egg	2.07±0.07	1.86±0.09	-	-	-	-
Larva	1.64±0.09	1.43±0.07	-	-	-	-
Protonymph	1.86±0.09	1.57±0.13	4.86±0.34	2.66±0.24	3.86±0.26	2.50±0.14
Deutonymph	2.28±0.10	1.93±0.07	16.86±1.06	7.43±0.51	8.86±0.26	4.62±0.16
T. immatures	5.78±0.18	4.73±0.45	21.71±1.08	4.48±0.23	12.71±0.29	3.67±0.35
Life cycle	7.86±0.21	6.78±0.24	-	-	-	-
Generation	9.57±0.23	-	-	-	-	-
Pre-oviposition	1.71±0.10	-	16.71±1.22	9.90±0.80	-	-
Post-oviposition	2.86±0.21	-	25.43±0.84	9.23±0.86	-	-
Longevity	16.71±0.82	8.28±0.29	201.43±8.05	12.12±0.40	60.28±1.97	7.29±0.21
Life span	24.57±0.98	15.07±0.29	223.14±8.64	9.11±0.25	73.00±1.99	6.19±0.10

±SE Standard Error

Table 2: Fecundity and prey consumption of *Typhlodromus malus* during oviposition period when fed on immatures of *Tetranychus urticae* at 27±4°C.

Oviposition period (in days)	No. deposited egg/ female		No. consumed prey individuals/ female	
	Total average	Daily mean	Total average	Daily Mean
12.14±0.8	19.86±1.53	1.56±0.11	159.28±9.11	13.23±0.51

±SE Standard Error

Ovipositing *E. finlandicus* females consumed the greatest number of prey (148.55), but only a mean of 14.84 prey in the pre-oviposition period and 3.00 in the post-oviposition period (Abdallah *et al.*, 2001). During adulthood of *Typhlodromus capsicum* females and males fed on a total average of 124.28 and 49.00 *T. urticae* immature stages, respectively (Basha, 2001). During the life span, females and males of *T. malus* attacked 223.14 and 73.00 immature stages of *T. urticae*, respectively (Table 1). Females and males of *Neoseiulus seminudus* devoured 296.29 and 159.33 prey, respectively, when fed on *T. urticae* immature stages throughout their life span (Basha, 2002).

Prey stage preference

Data presented in Table 3 indicated that the mean consumption rates of *T. malus* females were significantly different between the various prey stages but not between adults. Prey consumption was inversely related to prey size, where the predator female consumed mostly eggs (4.37 items/day), followed by prey larvae (3.47), protonymphs (2.33), and deutonymphs (1.27). Consumption of prey by adult females (0.73) and males (0.53) was very rare; these numbers actually represent the consumption of just eleven females and eight males of 25 initial individuals per 15 replicates.

Table 3: *Typhlodromus malus* consumption of immature and adult stages of *Tetranychus urticae*; mean Consumption (Number of items per day) and proportion consumed (Na/ No: Na, prey number attacked per predator; No, initial prey number).

Prey stage	Mean± SE	Na / No
Egg	4.73± 0.12 a	0.189
Larva	3.47± 0.13 b	0.138
Protonymph	2.33± 0.13 c	0.093
Deutonymph	1.27± 0.12 d	0.050
Female	0.73± 0.12 e	0.029
Male	0.53± 0.13 e	0.021
L.S.D _{0.01}	0.464	

*Mean values followed by a different letter are significantly different from each other.

±SE Standard Error

The predator females removed about 18.93, 13.87, 9.33, 5.07, 2.93, and 2.13% of the total number of *T. urticae* stages; eggs, larvae, protonymph, deutonymph, females, and males, respectively (Table 3). Badii *et al.*, (2004) indicated that adult females of the phytoseiid species *Euseius hibisci* devoured significantly more prey eggs than other stages of *T. urticae*.

This observation agrees closely with those of Abdallah *et al.*, (2001), who mentioned that immature stages of *E. finlandicus* females consumed more spider mite larvae (11.85) in total than males (9.18). Kasap and Atlihan (2011) showed that the predatory mite *Kampimodromus aberrans* female consumed significantly more prey larvae of *T. urticae* than other prey stages. Fantinou *et al.*, (2012) cleared that the maximum number of *T. urticae* females consumed by female of the predatory mite *Iphiseius degenerans* was 4 per day. Abdallah *et al.*, (2001) indicated that adult *E. finlandicus* females consumed an average of 166.38 spider mite protonymph during the adult stage compared to an average of 66.55 by males. The number of preys protonymphs consumed per day by females was highest in the oviposition period, lower in the pre-oviposition and lowest in the post-oviposition period.

CONCLUSION

These findings suggested that the phytoseiid species *T. malus* could be a promising potential biocontrol agent for the two-spotted spider mite species *T. urticae* in Egypt.

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CONFLICT OF INTEREST

There are no conflicts of interest

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الملخص العربي

بعض الخصائص الحيوية للحلم *Typhlodromus malus* كمفترس للحلم العنكبوتى *Tetranychus urticae*

هند عبد العزيز النشترى

قسم وقاية النبات - كلية الزراعة - جامعة الزقازيق - الزقازيق - مصر

تم دراسة دورة حياة وتكاثر ومعدل استهلاك الفرائس للحلم الفيتوسيدى *Typhlodromus malus* Basha & Yousef والتي لم يسبق تحديدها وذلك عند تغذيته على الأطوار الغير كاملة للحلم العنكبوتى ذو البقعتين *Tetranychus urticae* Koch تحت الظروف المعملية على درجة حرارة $27 \pm 4^\circ \text{C}$ وذلك لتقييم دوره فى مكافحة البيولوجية لهذه الآفة الأكاروسية.

بلغ متوسط الفترة الأجمالية للأطوار الغير كامله للحلم الفيتوسيدى 5.78 يوم للأنثى و4.73 يوم للذكر والتي تم خلالها استهلاك 21.71 و12.71 فريسة على التوالي.

أثبتت الأنثى البالغة للمفترس *T. malus* كفاءتها من حيث استهلاكها لأعداد أكثر من الفرائس مقارنة بالذكر. كما بلغ متوسط فترة الجيل 9.57 يوم، استمرت الأنثى البالغة فى وضع البيض لمدة 12.14 يوم، حيث تغذت على متوسط إجمالى بلغ 159.28 فرد ووضعت بمتوسط كلى ويومى 19.86 و1.56 بيضة على التوالي. تم تقديم أعداد ثابتة من الأطوار المختلفة للحلم النباتى *T. urticae* للأنثى المفترس *T. malus* لمعرفة الأطوار التى تفضلها عند التغذية.

الكلمات الدالة: مكافحة البيولوجية، فيتوسيدى، افتراس، الحلم العنكبوتى.