Exp Appl Acarol (2008) 44:27–36
DOI 10.1007/s10493-007-9124-8

Life history of the predatory mite *Phytoseiulus fragariae* on *Tetranychus evansi* and *Tetranychus urticae* (Acari: Phytoseiidae, Tetranychidae) at five temperatures

Geraldo José Nascimento de Vasconcelos · Gilberto José de Moraes · Ítalo Delalibera Júnior · Markus Knapp

Received: 6 July 2007 / Accepted: 19 November 2007 / Published online: 4 December 2007

Abstract *Tetranychus evansi* Baker and Pritchard and *Tetranychus urticae* Koch (Acari: Tetranychidae) are important pests of Solanaceae in many countries. Several studies have demonstrated that *T. urticae* is an acceptable prey to many predatory mites, although the suitability of this prey depends on the host plant. *T. evansi*, has been shown to be an unfavorable prey to most predatory mites that have been tested against it. The predator *Phytoseiulus fragariae* Denmark and Schicha (Acari: Phytoseiidae) has been found in association with the two species in Brazil. The objective of this work was to compare biological parameters of *P. fragariae* on *T. evansi* and on *T. urticae* as prey. The study was conducted under laboratory conditions at 10, 15, 20, 25 and 30°C. At all temperatures, survivorship was lower on *T. evansi* than on *T. urticae*. No predator reached adulthood at 10°C on the former species; even on the latter species, only about 36% of the predators reached adulthood at 10°C. For both prey, in general, duration of each life stage was shorter, total fecundity was lower and intrinsic rate of population increase (r_m) was higher with increasing temperatures. The slower rate of development of *P. fragariae* on *T. evansi* resulted in a slightly higher thermal requirement (103.9 degree-days) on that prey than on *T. urticae* (97.1 degree-days). The values of net reproduction rate (R_0), intrinsic rate of increase (r_m) and finite rate of increase (λ) were significantly higher on *T. urticae*, indicating faster population increase of the predator on this prey species. The highest value of r_m of the predator was 0.154 and 0.337 female per female per day on *T. evansi* and on *T. urticae*, respectively. The results suggested that *P. fragariae* cannot be considered a good predator of *T. evansi*.

Keywords *Tetranychus evansi* · *Tetranychus urticae* · *Phytoseiulus fragariae* · Two-spotted spider mite · Predatory mites · Biological control · Solanaceae

G. J. N. de Vasconcelos (✉) · G. J. de Moraes · Í. Delalibera Júnior
Escola Superior de Agricultura "Luiz de Queiroz", Departamento de Entomologia, Fitopatologia e Zoologia Agrícola, Universidade de São Paulo, Avenida Pádua Dias, 11, CP. 9, 13418-900 Piracicaba, SP, Brazil
e-mail: vasconce@esalq.usp.br

M. Knapp
ICIPE – African Insect Science for Food and Health, P.O. Box 30772, 00100 Nairobi, Kenya

Introduction

Tetranychus evansi Baker and Pritchard and *Tetranychus urticae* Koch are important pests of Solanaceae in many countries (Jeppson et al. 1975). *T. evansi* has been reported from countries in the Americas, Africa, Europe and, more recently, Asia (Ferreira and Carmona 1995; Meyer 1996; Bolland et al. 1998; Bonato 1999; Ferragut and Escudero 1999; Kreiter et al. 2002; Knapp et al. 2003; Ho et al. 2004; Duverney et al. 2005; Migeon 2005). It shows a strong preference for solanaceous plants. *T. urticae* is a cosmopolitan species that attacks a wide range of hosts of different families (Bolland et al. 1998).

Several studies have demonstrated that *T. urticae* is an acceptable prey to a large number of predatory mites on many different plants (Kostiainen and Hoy 1996), although the suitability of this prey for predatory mites depends on the host plant. For example, a few phytoseiid species can be used to control *T. urticae* on solanaceous plants. *T. evansi*, has been shown to be an unfavorable prey to most predatory mites that have been tested against it (Moraes and Lima 1983; Moraes and McMurtry 1985, 1986; Escudero and Ferragut 2005; Rosa et al. 2005). An exception is a Brazilian strain of *Phytoseiulus longipes* Evans, which seems to be a good predator of that pest species (Furtado et al. 2006, 2007).

Another predator of the same genus, *Phytoseiulus fragariae* Denmark and Schicha, was recently found in association with *T. evansi* on *Solanum americanum* Mill. in Uruguaiana, State of Rio Grande do Sul, Brazil (Furtado et al. 2006). Until then, this predator was only known from Brazil in association with *T. urticae*, on *Fragaria* sp. and *Bidens pilosa* L. (Denmark and Schicha 1983; Takahashi and Chant 1993).

Phytoseiulus fragariae is the least studied of the mites in the genus *Phytoseiulus*. At 26°C, and using eggs of *Tetranychus pacificus* McGregor as prey, Takahashi and Chant (1992, 1994) reported it to have longer developmental time and lower reproductive capacity than reported for other species of this genus. However, Fraga (1996) reported that at 27°C and with eggs of *T. urticae* as prey, *P. fragariae* has a developmental rate comparable to that of *Phytoseiulus macropilis* (Banks) (Smith and Summers 1949; Prasad 1967) and *Phytoseiulus persimilis* Athias-Henriot (Laing 1968; Amano and Chant 1977). The fact that different stages of *P. fragariae* have been found associated with populations of *T. evansi* on solanaceous plants in Brazil could indicate that this biotype is a potential biocontrol agent of that pest. Considering that until now a single phytoseiid species has shown potential as a predator of *T. evansi* (Furtado et al. 2006, 2007), the determination of a second prospective predator would be extremely desirable.

The objective of this paper is to evaluate biological parameters of *P. fragariae* on *T. evansi* and *T. urticae* as prey, at five temperatures, with special reference to evaluate its potential as biocontrol agent against *T. evansi* on Solanaceae.

Materials and methods

This work was conducted in the Acarology Laboratory of "Departamento de Entomologia, Fitopatologia e Zoologia Agrícola, Escola Superior de Agricultura Luiz de Queiroz (ESALQ)—Universidade de São Paulo", where voucher specimens of the species used in this study were deposited.

Tetranychus evansi and *T. urticae* were obtained from colonies that had been maintained in the laboratory for about 5 years before the beginning of the study, on plants of *Lycopersicon esculentum* var. Kadi GI Mill. and *Canavalia ensiformis* (L.) DC., respectively. *P. fragariae* was obtained from a laboratory colony initiated with about 40 specimens

(different life stages) collected in Uruguaiana about 6 months before the beginning of the study. The colony of the predator was maintained using an adaptation of the method of McMurtry and Scriven (1965), at 25.5 ± 0.5°C, 88 ± 7% RH and 12:12 h light:dark, and fed *T. urticae* on leaflets of *C. ensiformis*.

The study was initiated with newly laid eggs of *P. fragariae*. To obtain them, groups of about 100 females of the predator were transferred from the stock colony to a leaflet of *C. ensiformis* infested with *T. urticae*. Four hours later, single eggs laid by the predator were transferred to the experimental units, repeating this process until 50 eggs per treatment were available. Each experimental unit consisted of a plastic Petri dish (2.6 cm in diameter × 1.0 cm high), whose bottom was covered with a disk of filter paper, onto which a leaf disk (2.0 cm in diameter) of *S. americanum* infested with all developmental stages of *T. evansi* or *T. urticae* was placed. The filter paper was moistened daily with distilled water. Predators were transferred to new units every third day. The upper opening of each unit was sealed with a transparent plastic film (Magipack®). For each prey species, development, adult survival and fecundity were investigated in climatic chambers at 10 ± 0.8, 15 ± 0.8, 20 ± 0.8, 25 ± 0.8 and 30 ± 0.8°C and 12:12 h light:dark. Relative humidity in the experimental units was not controlled, but should be close to saturation, as the units were kept closed and water was added daily to the filter paper disk in it to prevent dehydration of the leaf disk.

During immature development, the experimental units were observed every 8 h, to determine the duration of each developmental stage and the corresponding survivorship. With those data, thermal requirements of each developmental stage and of the whole immature development were calculated, using the coefficient of variation method (Arnold 1959). A male obtained in this study or taken from the stock colony was introduced to each arena containing a recently emerged female. The couple was maintained together up to the end of the study; dead males were replaced by new males. When mites were in the adult stage, observations were carried out every 24 h, to determine the reproductive parameters (preoviposition, oviposition and postoviposition periods as well as daily oviposition) and longevity. The sex ratio of the studied generation was determined based on the eggs laid on the third and fourth day of oviposition. To do that, eggs were transferred individually with a fine brush to a unit similar to that used for the stock colony, which also contained leaflets infested with *T. urticae*; that unit was maintained under the same condition mentioned for the stock colony. Mites were sexed soon after reaching adulthood. Fertility life tables (Birch 1948; Southwood 1978) were constructed using the method proposed by Maia et al. (2000), which consists on a statistical package developed using the SAS system for Windows®, version 6.12, that uses jackknife to estimate parameters for fertility life tables. At each temperature, averages of each parameter on both prey were compared using Student's *T*-test ($P \leq 0.05$). Regression equations were calculated to relate the variation of each evaluated parameter with the variation in temperature.

Results and discussion

Immature development

A rather erratic pattern was observed for the variation of survivorship rates of the whole immature phase of the predator at the different temperatures when prey was *T. evansi*; a quadratic equation significantly described the relation between those parameters ($R^2 = 73.7\%$). When prey was *T. urticae*, survivorship progressively increased with

increasing temperatures; a quadratic response curve fitted the observed data ($R^2 = 77.7\%$). At all temperatures, survivorship was lower on *T. evansi* than on *T. urticae*. When prey was *T. evansi*, mortality of the whole immature phase was very high at 10°C; it was low in the egg stage, but high in the larval stage and very high in the protonymphal stage; none of the predators that succeeded in completing the latter stage was able to complete the deutonymphal stage on this prey. Even on *T. urticae*, only about a third of the predators reached the adult stage at that temperature (Table 1).

Lower survivorship on *T. evansi* than on *T. urticae* was also observed by Escudero and Ferragut (2005) for *Neoseiulus californicus* (McGregor) and *P. persimilis*. However, Furtado et al. (2007) observed higher survivorship of *P. longipes* on *T. evansi* than on *T. urticae*.

On both prey species, progressively shorter durations of each immature stage and of the whole immature phase were observed with increasing temperatures (Table 1). In each case, a quadratic response curve fitted the observed data well ($R^2 \geq 86.9\%$). Duration of the whole immature phase of *P. fragariae* at 25°C was slightly longer than reported by Takahashi and Chant (1992) and Fraga (1996) at 27°C (5.0 days) and 26°C (4.4 days), respectively.

Significant differences were not observed concerning the duration of the larval stage on the different prey at each temperature. Because of poor survivorship of post-larval stages of *P. fragariae* at 10°C, no comparisons were carried out concerning the duration of subsequent preimaginal developmental stages at this temperature. At other temperatures, differences were always significant for the post-larval stages, except for the protonymphal stage at 25°C; in other cases, development was always faster when the prey was *T. urticae*. Congruently, the duration of the total immature developmental time was significantly shorter on *T. urticae* reared individuals at all tested temperatures. Escudero and Ferragut (2005) also observed shorter duration of the immature phase of *P. persimilis* on *T. urticae* than on *T. evansi*. However, Furtado et al. (2007) did not find a significant effect of these two prey species on the duration of the immature phase of *P. longipes*.

Also because of the low survivorship of post-larval stages of *P. longipes* at 10°C, only data at higher temperatures were used in the determination of thermal requirements of those stages and of the whole immature phase when prey was *T. evansi*. For the whole immature development of *P. fragariae*, calculated lower threshold temperature for development (t_0) was 8.4 and 8.0°C on *T. evansi* and *T. urticae*, respectively (Table 1). However, because of high mortality at the protonymphal stage at 10°C, the higher values of the threshold for that stage ($t_0 = 10.3$ on *T. evansi* and 8.7°C on *T. urticae*) should be considered as the actual limiting values. The calculated lower threshold temperature for the protonymphal stage on *T. evansi* was close to the value determined by Badii and McMurtry (1984) for *P. longipes* on *T. pacificus* (10.8°C) but lower than the value determined by Silva et al. (2005) for *P. macropilis* on *T. urticae* (12.7°C).

The slower rate of development of *P. fragariae* on *T. evansi* resulted in a slightly higher thermal requirement (103.9 degree-days) on that prey than on *T. urticae* (97.1 degree-days). On both prey, the requirement was considerably higher than that reported by Badii and McMurtry (1984) for *P. longipes* (75.9 degree-days) and by Silva et al. (2005) for *P. macropilis* (66.0 degree-days).

Reproduction

Similarly to what was reported for immature development, on both prey species, progressively shorter durations of preoviposition, oviposition and postoviposition periods as well as adult female longevity were observed with increasing temperatures (Table 2). With one

Table 1 Durations (days ± SE) of the immature stages, survivorship, equations relating each parameter with temperature, lower threshold temperature of development (t_0) and thermal constant (K), for *Phytoseiulus fragariae* on *Tetranychus evansi* and *Tetranychus urticae* as prey at different temperatures

Parameter	Prey	Temperature (°C)[A]					Thermal requirements		Regression	
		10	15	20	25	30	t_0 (°C)	K (GD)	Equation[B]	R^2 (%)
Egg	*T. evansi*	17.6 ± 0.4 [92][C]	5.7 ± 0.1 [94]	3.0 ± 0.0 [100]	2.2 ± 0.1 [100]	1.9 ± 0.1 [80]	7.8	39.3	$\hat{y} = 45.140 - 3.567T + 0.072T^2$	90.8
	T. urticae	16.3 ± 0.4 [92]	5.7 ± 0.1 [96]	3.0 ± 0.0 [98]	2.2 ± 0.1 [98]	2.0 ± 0.1 [98]	7.5	40.4	$\hat{y} = 41.380 - 3.236T + 0.065T^2$	91.0
Larva	*T. evansi*	5.7 ± 0.3a [58]	1.9 ± 0.0a [94]	1.0 ± 0.0a [100]	0.7 ± 0.0a [96]	0.7 ± 0.0a [76]	7.6	13.6	$\hat{y} = 14.680 - 1.161T + 0.023T^2$	91.9
	T. urticae	5.4 ± 0.2a [76]	1.9 ± 0.1a [96]	1.0 ± 0.0a [96]	0.7 ± 0.0a [98]	0.7 ± 0.0a [98]	7.2	14.1	$\hat{y} = 13.780 - 1.081T + 0.022T^2$	92.8
Protonymph	*T. evansi*	18.4 ± 1.9 [6]	4.2 ± 0.1a [90]	2.2 ± 0.1a [92]	1.1 ± 0.0a [92]	1.1 ± 0.1a [74]	10.3	19.7	$\hat{y} = 49.780 - 4.103T + 0.084T^2$	86.9
	T. urticae	13.5 ± 0.8 [46]	3.4 ± 0.1b [94]	1.6 ± 0.1b [96]	1.0 ± 0.0a [98]	0.8 ± 0.0b [98]	8.7	14.9	$\hat{y} = 36.180 - 2.956T + 0.060T^2$	88.2
Deutonymph	*T. evansi*	–	4.1 ± 0.2a [80]	2.8 ± 0.2a [74]	1.8 ± 0.1a [86]	1.4 ± 0.1a [72]	7.3	32.7	$\hat{y} = 10.895 - 0.587T + 0.009T^2$	99.7
	T. urticae	10.8 ± 0.8 [36]	3.2 ± 0.1b [92]	1.9 ± 0.0b [96]	1.4 ± 0.0b [98]	1.0 ± 0.0b [98]	7.9	22.9	$\hat{y} = 27.420 - 2.165T + 0.043T^2$	87.4
Immature phase	*T. evansi*	–	15.9 ± 0.2a [80]	9.0 ± 0.2a [74]	5.8 ± 0.1a [86]	5.1 ± 0.1a [72]	8.4	103.9	$\hat{y} = 54.420 - 3.502T + 0.062T^2$	99.7
	T. urticae	46.7 ± 1.0 [36]	14.2 ± 0.2b [92]	7.5 ± 0.1b [96]	5.5 ± 0.1b [98]	4.6 ± 0.1b [98]	8.0	97.1	$\hat{y} = 120.760 - 9.618T + 0.194T^2$	89.6

[A] For each developmental stage and at each temperature, durations followed by the same letter are not statistically different (T-test, $P < 5\%$)

[B] T = temperature in °C

[C] % survivorship at the respective stage

Table 2 Durations (days ± SE) of the preoviposition, oviposition, postoviposition and longevity, fecundity (eggs/female ± SE) and sex ratio (% females) of *Phytoseiulus fragariae* on *Tetranychus evansi* and *Tetranychus urticae* as prey at different temperatures

Parameter	Prey	Temperature (°C)[A]					
		15	20	25	30	Regression equation[B]	R^2 (%)
Preoviposition	*T. evansi*	4.9 ± 0.6a [25]	4.0 ± 0.5a [28]	3.5 ± 0.3a [32]	2.0 ± 0.5a [26]	$\hat{y} = 7.529 - 0.172T$	92.7
	T. urticae	4.1 ± 0.3a [36]	2.2 ± 0.3b [36]	1.8 ± 0.2b [35]	1.0 ± 0.2b [42]	$\hat{y} = 6.640 - 0.194T$	95.2
Oviposition	*T. evansi*	16.9 ± 2.2b [25]	18.5 ± 2.0b [28]	11.6 ± 1.1b [30]	7.6 ± 0.6b [26]	$\hat{y} = 16.990 + 2.036T - 0.072T^2$	91.3
	T. urticae	29.6 ± 0.9a [36]	25.8 ± 1.8a [34]	17.1 ± 2.3a [32]	11.9 ± 0.7a [42]	$\hat{y} = 48.910 - 1.236T$	99.0
Postoviposition	*T. evansi*	10.9 ± 0.9a [21]	9.3 ± 1.4a [19]	4.1 ± 0.7a [21]	3.7 ± 0.6a [24]	$\hat{y} = 18.663 - 0.524T$	87.5
	T. urticae	9.6 ± 0.5a [34]	8.0 ± 1.4a [34]	4.2 ± 0.9a [29]	2.1 ± 0.6b [37]	$\hat{y} = 17.810 - 0.526T$	98.8
Female longevity	*T. evansi*	28.6 ± 1.7b [25]	26.4 ± 2.3b [28]	16.7 ± 0.9b [32]	11.9 ± 1.1b [26]	$\hat{y} = 47.709 - 1.184T$	95.8
	T. urticae	44.7 ± 0.6a [36]	36.7 ± 2.8a [36]	23.3 ± 2.2a [35]	14.2 ± 0.8a [42]	$\hat{y} = 76.930 - 2.098T$	99.6
Male longevity	*T. evansi*	31.3 ± 1.9b [19]	29.0 ± 6.8b [7]	22.8 ± 4.1a [6]	13.3 ± 2.5a [4]	$\hat{y} = 25.690 + 2.666T - 0.106T^2$	91.1
	T. urticae	39.4 ± 2.2a [8]	43.9 ± 8.4a [10]	18.8 ± 5.4b [7]	12.7 ± 0.9a [4]	$\hat{y} = 76.040 - 2.104T$	88.9
Total fecundity	*T. evansi*	11.0 ± 1.8b [25]	10.2 ± 1.6b [28]	9.3 ± 1.3b [30]	9.0 ± 1.3b [26]	$\hat{y} = 13.400 - 0.140T$	94.6
	T. urticae	47.6 ± 3.1a [36]	38.8 ± 1.6a [34]	35.9 ± 1.9a [32]	29.8 ± 2.1a [42]	$\hat{y} = 63.360 - 1.126T$	98.2
Sex ratio	*T. evansi*	57.5	75.9	86.3	82.9	$\hat{y} = -66.870 + 11.542T - 0.218T^2$	87.0
	T. urticae	83.0	78.3	81.4	91.3	$\hat{y} = 140.250 - 6.010T + 0.146T^2$	72.5

[A] For each phase and at each temperature means followed by the same letters are not statistically different (*T*-test; $P < 5\%$). Numbers in brackets = number of individuals used in data analysis

[B] T = temperature in °C

exception, the relation between the duration of these phases and temperature was linear ($R^2 \geq 87.5\%$); on *T. evansi*, the relation of the oviposition period to temperature levels corresponded to a quadratic function ($R^2 = 91.3\%$). In relation to adult male longevity, significant response curves were quadratic on *T. evansi* and linear on *T. urticae* ($R^2 = 91.1\%$ and 88.9%, respectively).

On both prey, slightly lower fecundity were progressively observed with increasing temperatures; in both cases, the relation between that parameter and temperature was linear (R^2 nearly 98%). For unknown reason, the variation of sex ratio was quite different on different prey along the range of temperatures considered in the study. On *T. evansi*, sex ratio increased from 15 to 20°C and decreased from 25 to 30°C ($R^2 = 87.0\%$ for a quadratic response). The trend was exactly the opposite on *T. urticae* ($R^2 = 72.5\%$ for a quadratic response) (Table 2).

The preoviposition period was significantly longer on *T. evansi*, except at 15°C. On the same prey, the oviposition period and female longevity were shorter, and total fecundity was lower than the respective values recorded for the *T. urticae* reared individuals at all temperatures. This suggests that *T. urticae* is a more suitable prey for *P. fragariae* than *T. evansi*. The total fecundity determined in the present study on *T. urticae* are slightly lower than those observed by Takahashi and Chant (1994) but much lower than observed by Fraga (1996), at comparable temperatures.

The postoviposition period was significantly longer for predators fed *T. evansi* at 30°C. An irregular pattern was observed when comparing adult male longevity, probably because of the low numbers of males at each temperature on either prey.

Moraes and McMurtry (1986) and Escudero and Ferragut (2005) also reported less favorable reproductive parameters for *P. persimilis* when prey was *T. evansi* than when it was *T. urticae*. Furtado et al. (2007) observed the opposite for *P. longipes*. In that case, although the oviposition period was similar on both prey, fecundity was higher when it was fed *T. evansi*.

On both prey, sex ratio of the progeny of the mites reared at the different temperatures was higher than 75% [females/(females + males)] at 20, 25 and 30°C, but only 57.5% on *T. evansi* at 15°C, suggesting a possible disturbance of the pseudo-arrhenotoky process of predators reared at relatively low temperature and fed an apparently unfavorable prey, resulting in the production of a proportionally higher number of sons (Sabelis and Nagelkerke 1988). Takahashi and Chant (1994) and Fraga (1996) reported sex ratios of about 80% for this predator. Escudero and Ferragut (2005) reported a sex ratio of nearly 50% for *P. persimilis* and *N. californicus* fed *T. evansi* and 73% when the same predators were fed *T. urticae*. Conversely, Furtado et al. (2007) reported sex ratio of nearly 90% for *P. longipes* fed either of those prey.

Fertility life table

Concurrently with what was reported for duration of each immature stage and each adult phase (preoviposition, oviposition and postoviposition), calculated generation time (T) was progressively shorter with increasing temperatures on both prey, the observed data fitting well quadratic response curves ($R^2 = 95.4\%$ on *T. evansi* and 97.3% on *T. urticae*) (Table 3). At 15 and 20°C, T values were significantly lower on *T. evansi*, but no differences were observed at 25 and 30°C. The values of net reproduction rate (R_0), intrinsic rate of increase (r_m) and finite rate of increase (λ) generally increased with increasing temperatures, except for R_0 on *T. evansi*, which increased up to 25°C but then decreased at 30°C ($R^2 = 77.6$–81.7% for R_0 and higher than 97% for the other two parameters). The positive

Table 3 Life table parameters (± confidence interval) of *Phytoseiulus fragariae* on *Tetranychus evansi* and *Tetranychus urticae* as prey at different temperatures

Parameter	Prey	Temperature (°C)[A]					
		15	20	25	30	Regression equation[B]	R^2 (%)
n[C]	*T. evansi*	25	28	32	26	–	–
	T. urticae	36	36	35	42	–	–
T	*T. evansi*	35.8 ± 12.1b	21.4 ± 7.1b	17.4 ± 4.9a	13.7 ± 4.5a	$\hat{y} = 104.535 - 6.221T + 0.107T^2$	93.8
	T. urticae	40.6 ± 11.1a	28.1 ± 7.7a	15.6 ± 4.3a	12.5 ± 3.2a	$\hat{y} = 112.410 - 6.166T + 0.094T^2$	97.3
R_0	*T. evansi*	5.5 ± 1.8b	6.1 ± 1.8b	8.5 ± 2.5b	7.3 ± 2.3b	$\hat{y} = -5.210 + 0.966T - 0.018T^2$	75.7
	T. urticae	24.5 ± 6.7a	39.7 ± 10.9a	29.7 ± 8.2a	34.1 ± 8.6a	$\hat{y} = -27.760 + 5.236T - 0.108T^2$	77.6
r_m	*T. evansi*	0.048 ± 0.016b	0.084 ± 0.028b	0.123 ± 0.041b	0.145 ± 0.052b	$\hat{y} = -0.049 + 0.007T$	98.4
	T. urticae	0.023 ± 0.014a	0.161 ± 0.044a	0.273 ± 0.076a	0.337 ± 0.085a	$\hat{y} = -0.177 + 0.017T$	99.5
λ	*T. evansi*	1.049 ± 0.358b	1.088 ± 0.347b	1.131 ± 0.329b	1.156 ± 0.388b	$\hat{y} = 0.942 + 0.007T$	99.5
	T. urticae	1.082 ± 0.296a	1.140 ± 0.312a	1.242 ± 0.344a	1.326 ± 0.336a	$\hat{y} = 0.822 + 0.017T$	99.5

[A] For each parameter and at each temperature, means followed by the same letters are not statistically different (T-test; $P < 5\%$)

[B] T = temperature in °C

[C] Number of individuals used in data analysis

values of those parameters indicated that the population of *P. fragariae* can increase on both prey. However, the values were significantly higher on *T. urticae*, indicating faster population increase of the predator. The low capacity for population growth of *P. fragariae* on *T. evansi* was due to the small production of offsprings, with low net reproduction values R_0 at all tested temperatures. The net reproduction rate determined at 25°C in this study was about half as high as reported by Fraga (1996), but comparable to that determined by Takahashi and Chant (1994). At 25°C, when prey was *T. evansi*, net reproduction rate was much lower for *P. persimilis* (Escudero and Ferragut 2005) but much higher for *P. longipes* (Furtado et al. 2007) than reported for *P. fragariae* in this study.

Although the results of this study showed a better performance of *P. fragariae* as a predator of *T. evansi* than the species studied by Moraes and McMurtry (1985) and Escudero and Ferragut (2005), it seems that it cannot be considered a good predator of that pest. The results of Furtado et al. (2007) are much more encouraging, and showed a much better performance of *P. longipes* on the same pest. Conversely, the results suggest that *P. fragariae* is a promising control agent of *T. urticae*. However complementary studies should be conducted to determine whether it could also be effective on solanaceous plants, had that prey developed for successive generations on such type of substrate.

Acknowledgments The authors thank "Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Ministério da Ciência e Tecnologia do Brasil" and the German Federal Ministry for Economic Cooperation and Development (BMZ) for financial support.

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