Euseius citrifolius DENMARK & MUMA PREDATION ON CITRUS LEPROSIS MITE *Brevipalpus phoenicis* (GEIJSKES) (ACARI: PHYTOSEIIDAE: TENUIPALPIDAE)

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RESUMO

Predação de *Euseius citrifolius* Denmark & Muma Sobre o Ácaro da Leprose dos Citros *Brevipalpus phoenicis* (Geijskes) (Acari: Phytoseiidae: Tenuipalpidae)

Estimou-se a atividade predatória de *Euseius citrifolius* Denmark & Muma (Acari: Phytoseiidae) sobre o ácaro da leprose dos citros, *Brevipalpus phoenicis* (Geijskes) (Acari: Tenuipalpidae). As larvas, ninfas e fêmeas adultas foram semelhantes e superiores na atividade predatória sobre o ácaro da leprose que os machos adultos. Dentre os estágios imaturos, a larva foi a mais atacada pelo predador, e o aumento da relação predador: presa resultou em níveis maiores de prepdação. A presença da verrugose nos frutos causou uma diminuição significativa na predação de *E. citrifolius* sobre *B. phoenicis*.

PALAVRAS-CHAVE: Arthropoda, controle biológico, atividade predatória, relação predador-presa, verrugose.

ABSTRACT

The predatory activity of *Euseius citrifolius* Denmark & Muma (Acari: Phytoseiidae) upon the citrus leprosis mite, *Brevipalpus phoenicis* (Geijskes) (Acari: Tenuipalpidae) was studied. It was found that the phytoseiid larva, nymph and adult female, showed similar levels of predation, and were better predators than adult males. Among the immature stages of prey, the larval stage was the most frequently consumed by all life stages of the predator. Increasing predator: prey ratios resulted in higher predation rates. The presence of citrus scab disease on the fruits caused a significant decrease in predation of *B. phoenicis* by *E. citrifolius*.

KEY WORDS: Arthropoda, biological control, predatory activity, predator: prey ratio, scab disease.

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INTRODUCTION

The citrus virus disease called leprosis has long been cited as one of the most important factors that cause yield reductions in brazilian citriculture. This virus is reported to be transmitted by the brevipalpid mite, *Brevipalpus phoenicis* (Geijskes). Though this pest has long been controlled by pesticides many problems have been related to chemical sprays for its control (Violante Neto 1987). Commonly, 50% of the total cost of citrus acaricides is due to the control of this mite which means ca. 20% of the total cost of production. Such intensive use of chemicals poses a risk to the ecological balance of the environment and results in mites resistance to acaricides. The sweet orange scab disease, *Elsinoe australis* (Bit & Jenk) promote increases in leprosis mite populations because it prefers to live in lesions caused by this fungus on fruits (Fetchenberger 1988).

There are many predators in the citrus-ecosystem which may suppress growth of leprosis mite populations (Muma 1971). One of the most effective groups of beneficial organisms refers predatory mites of the family Phytoseiidae (McMurtry *et al.* 1970).

This research was undertaken to characterize the stage-specific activity of the predatory phytoseiid mite *Euseius citrifolius* Denmark & Muma. on the different stages of the leprosis mite, and to describe the influence on predation prey density or the presence/absence of the scab disease on fruits.

MATERIALS AND METHODS

Tests were conducted in a laboratory of the Department of Entomology and Nematology of the Universidade Estadual Paulista, Jaboticabal, State of São Paulo, Brazil. The laboratory temperature was maintained at 25±3°C, relative humidity of 60±10%, and photophase of 12 hours. Arenas of 11cm^2 were prepared on orange fruits previously cleaned with distilled water to exclude other mites and insects. Fruits were wrapped with a black cotton fabric with a circular hole on its top which formed the arena. The fruit was then positioned into a white plastic cup of 7.5 and 5.0 cm of top and botton diamter, and 10.5 cm on height. Distilled water placed into about half of the described plastic glass kept the fabric moist which prevented escape of the mites from the arenas. *E. citrifolius* were obtained from a stock colony maintained at the Department of Entomology and Nematology, continously fed castor bean (*Ricinus comunis* L.) pollen. To avoid possible interference of previous feeding, predators were maintained without any food for 24 hours before observations started.

Leprosis mites were collected from an orchard (cv. 'Valencia') which did not receive chemical spray. Prey and predators were transferred to the arenas using a soft fine hair brush. Each predator stage was evaluated at 4 densities of each prey stage. The following predator: prey ratios were utilized: 1:5, 1:10, 1:15, 1:20. All combinations were tested on fruits with and without scab disease. The statistical design adopted was a completely randomized factorial scheme (5 x 4 x 4 x 2) and 4 replicates. Twenty four hours after introducing predators and prey to the arenas, the numbers of live leprosis mites, dead mites in the water barrier, and mites killed by predators or by unknown causes, were evaluated. Natural mortality was corrected using the Abbott's formula. In addition, when predators died in the water at the edge of the arena or had molted, data were not considered and the test repeated.

Table 1. Mean number of adult female *B. phoenicis* killed and mortality of prey killed by different stages of *Euseius citrifolius*.

Stages of *E. citrifolius*	Means: Prey killed	Means: Mortality[1] (%)
Female	3.6 a[2]	35.1 a[2]
Nymph	3.5 a	33.1 a
Larva	3.0 a	29.7 a
Male	2.0 b	22.4 a
Check (no predator)	-	2.0 c

[1]Formula: % Mortality = [mites killed/(total mites - escaped mites)]. 100 (from 5 adult prey exposed to each predator stage/rep).
[2]Means followed by the same letter did not differ by Tukey's test ($P < 0.01$).

RESULTS

General Predation Efficiency. Adult female predators exhibited higher feeding rates on all stages of prey than adult males or immatures. Nymphs and larvae exhibited reduced rates of predation (Table 1), but those rates were similar to that of females ($P < 0.01$). Adult male predator was significantly less efficient than other predator stages. Larval stage of *B. phoenicis* was clearly preferred ($P < 0.01$) by larvae, nymphs, and adults of *E. citrifolius*. Nymphs and eggs were equally attacked, but adults were significantly less attacked (Table 2, Fig. 1).

Table 2. Mean number killed and mortality of different stages of *Brevipalpus phoenicis* (larva, nymph, egg, and adult) by *Euseius citrifolius*.

Stages of *B. phoenicis*	Prey killed	Mortality[1] (%)
Larva	5.0 a[2]	39.1 a
Nymph	3.3 b	28.0 b
Egg	3.2 b	24.5 b
Adult	0.5 c	6.4 c

[1]Formula: % Mortality = [mites killed/(total mites - escaped mites)].100.
[2]Means followed by the same letter did not differ by the Tukey's test ($P < 0.01$).

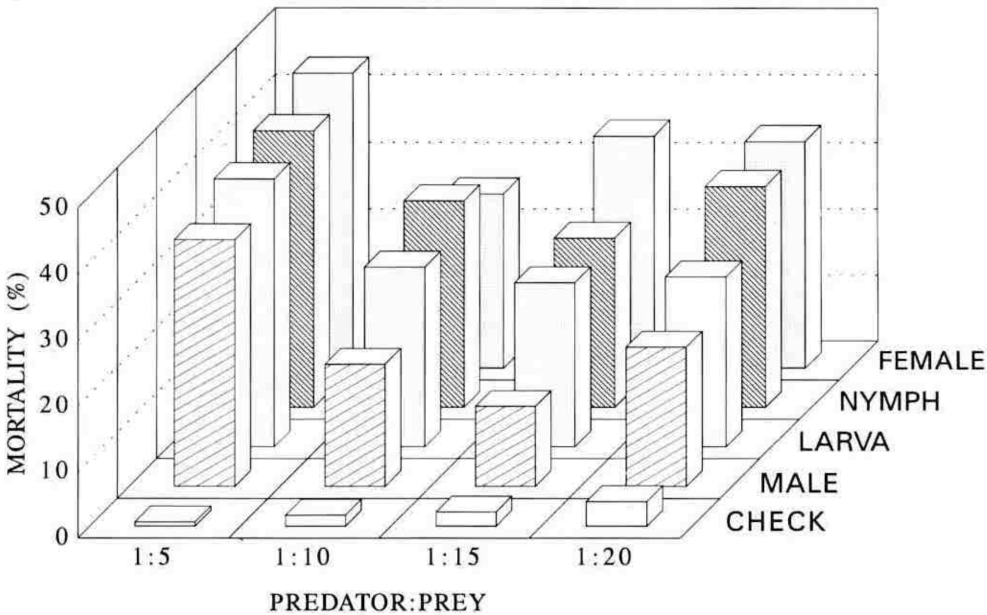

Figure 1. Mortality of different stages of the citrus leprosis mite by the different stages of the predatory mite *Euseius citrifolius*. CLM Stages = egg, larva, nymph (protonymph + deutonymph), adult. Predators treatments = check (no predators), male (adult male), larva, nymph (protonymph + deutonymph), and female (adult female).

Interaction between *E. citrifolius* predation (different stages) on *B. phoenicis* (different stages), is depicted in Fig. 2. Adults were least consumed by the phytoseiid predator. The highest rates of predation were showed by *E. citrifolius* female on the larval, egg, nymph and adult prey stages, in decreasing order. Larval stage of *B. phoenicis* was most killed by *E. citrifolius*.

Influence of Prey Density. The number of *B. phoenicis* consumed is a function of the predator: prey ratio. Greater numbers were consumed per predator at high ratios than at low ratios (Table 3).

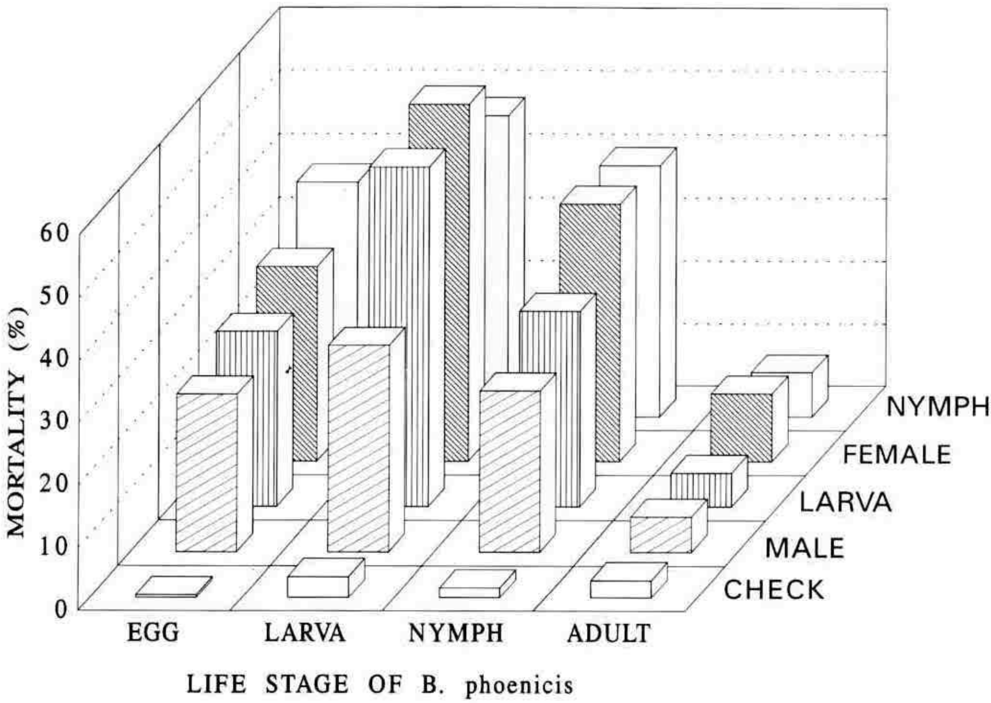

Figure 2. Influence of predator: prey ratio on the predation activity of stages of the predatory mite *Euseius citrifolius* un CLM.

Influence of Fruit Scab Disease on Predation. The scab disease *(E. australis)* symptoms on fruit skin negatively influenced predation of *E. citrifolius* on *B. phoenicis* ($P < 0.01$) (Table 4, Figs 3, 4). Highest mortality rates were generally reached in the treatment containing 1 predator per 5 prey on fruits without scab (Table 5). Under those conditions, predator larvae caused mortalities of 90 and 70% on *B. phoenicis* nymphs, larva, and eggs, respectively; nymphs killed 100, 75 and 60% of the *B. phoenicis* nymphs, larva, and eggs, respectively; and adult females killed 70, 100, and 70% of the CLM nymph, larva and egg, respectively. Male predators at 1:5 predator: prey ratio were able to kill 75 and 70% of the *B. phoenicis* nymphs and larvae, but only 30% of the eggs.

DISCUSSION

In general, larvae, nymphs and adult females of *E. citrifolius* exhibited similar predatory activity upon *B. phoenicis*, and greater activity than adult males. The larval stage of some phytoseiids feed, while other species do not consume food during the larval period (Moraes & McMurtry 1981).

Table 3. Mean number of adults killed and mortality of *Brevipalpus phoenicis* attacked by adult female *Euseius citrifolius*, in treatments of different prey densities.

Treatments (predator:prey)	Number killed/individual predator	Mortality[1] (%)
1 : 20	4.6 a[2]	23.7 ab
1 : 15	3.1 b	20.0 b
1 : 10	2.3 c	21.1 b
1 : 5	2.0 c	33.0 a

[1]Formula: % Mortality = [mites killed/(total mites - escaped mites0].100.
[2]Means followed by the same letter did not differ by the Tukey's test ($P < 0.01$).

McMurtry *et al.* (1970) stated that larvae have a reduced searching capacity for prey as compared to nymphs and adults. Generally, females constitute the most voracious phase of phytoseiids, which was evident in the data. An important factor potentially influencing the outcome of our investigation is that, with the exception of larvae, predators had water available during the starvation period prior to predatory activity. It is possible that ingestion of water during the starvation period limited the amount of prey taken initially by predator mites. This factor may have influenced the response to predation obtained in this research, as the evaluation period was relatively short (24 hours).

The immature stages of *B. phoenicis* were preferred by different life phases of the predator. This result is in agreement with that reported by several authors (Burrell & McCormick 1964, McMurtry & Scriven 1964, Elbadry 1968, Zaher *et al.* 1969, Croft & McMurtry 1972, Takafuji & Chant 1976), regarding feeding preference of other phytoseiid species. It also

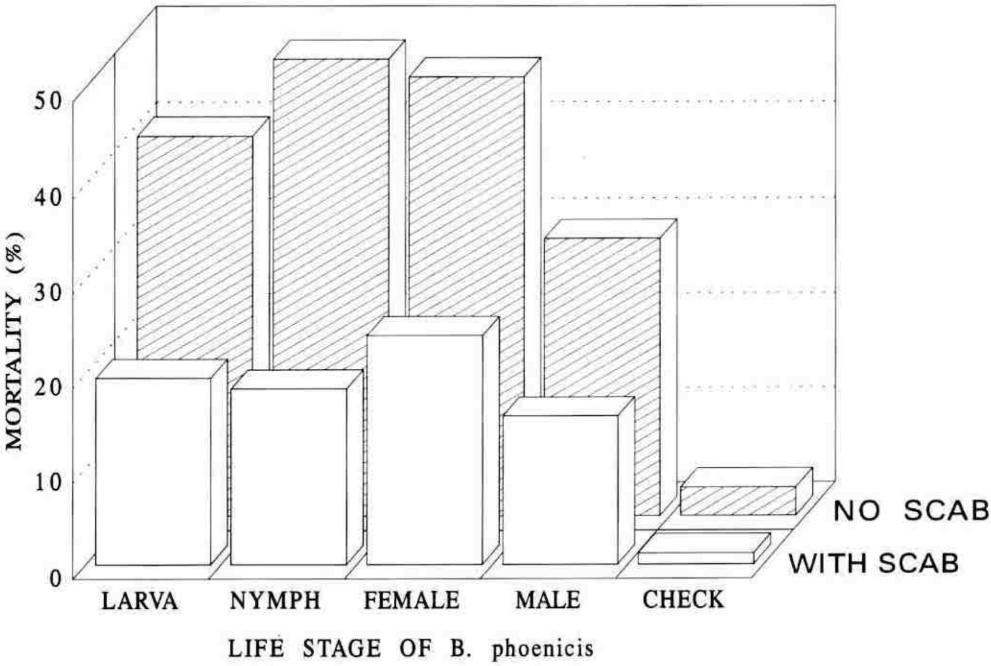

Figure 3. Predatory activity of different stages of the predatory mite *Euseius citrifolius* on the CLM and the presence or absence of citrus scab disease on fruits.

concurs with the findings of Moraes & McMurtry (1981) who studied *E. citrifolius* biology on *Tetranychus pacificus* (McGregor).

Of the immature stages, larval phase of *B. phoenicis* was the most preferred by all life stages of the predator, followed by nymphal and egg stges, respectively. This preference for larvae over eggs was also reported by Moraes & McMurtry (1981) for *E. citrifolius* feeding on tetranychid spider mites. According to the authors, *E. citrifolius* is not able to penetrate the tetranychid eggs.

Table 4. Mean number attacked and mortality of *Brevipalpus phoenicis* killed by the phytoseiid *Euseius citrifolius*, on orange fruits with and without scab disease symptoms.

Treatments (predator:Prey)	Number killed	Mortality[1] (%)
Without Scab	4.0 a[2]	33.2 a
With Scab	2.0 b	15.2 b

[1]Formula: % Mortality = [mites killed/(total mites - escaped mites)].100.
[2]Means followed by the same letter did not differ by the Tukey's test ($P < 0.01$).

In relation to prey densities, an increase in the degree of predation occurred as the predator: prey ratio decreased. Higher prey density resulted in increased rates of predation by *E. citrifolius*. Knisley & Swift (1971), showed a direct relation between the number and life stages of the predator mite and the number and life stages of the prey mite, i.e., the higher density of prey the higher density of predators either in number of individuals or of life stages present on the ecosystem.

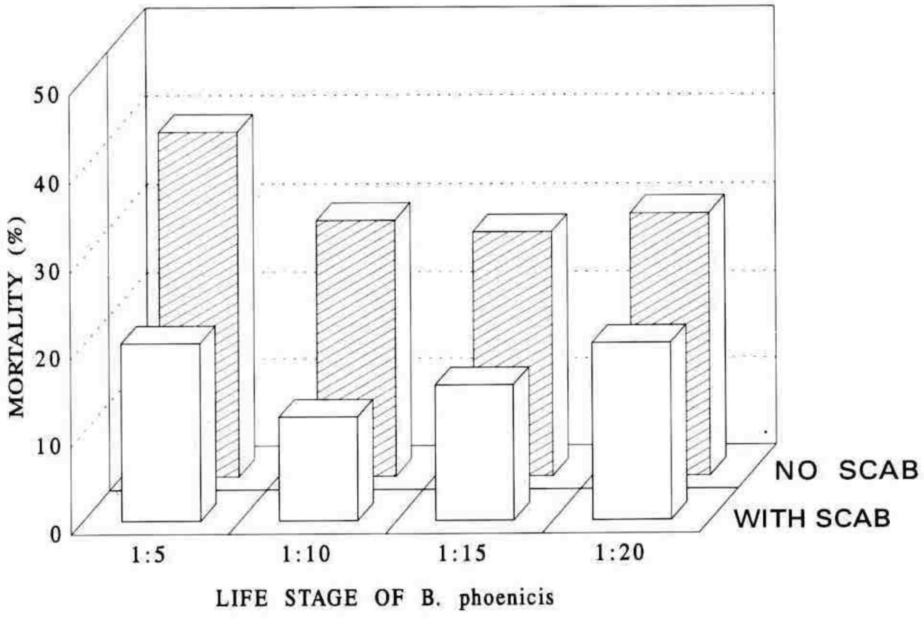

Figure 4. Influence of predator:prey densities and the presence or absence of citrus scab disease on fruits on the predation activity of *Euseius citrifolius*.

The presence of citrus scab disease on the fruit skin reduced the predatory activity of the phytoseiid on *B. phoenicis*. Apparently the scab provides a refuge where the predator cannot gain access.

Table 5. Predation rates of different stages of *Brevipalpus phoenicis* by the phytoseiid predator *Euseius citrifolius* observed at different prey densities.

	Percentage of *B. phoenicis* mortality							
Predator:	Eggs		Larvae		Nymphs		Adults	
prey ratios	no scab	with scab	no scab	with scab	no scab	with scab	no scab	with scab
Check								
0:5	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
0:10	2.5	0.0	8.0	0.0	0.0	0.0	2.7	0.0
0:15	0.0	0.0	6.9	6.9	3.5	0.0	1.7	3.4
0:20	1.2	0.0	2.5	7.6	2.8	1.2	10.2	4.2
Larva predator								
1:5	70.0	45.0	90.0	50.0	50.0	20.0	0.0	0.0
1:10	25.0	7.5	63.0	42.5	45.4	32.5	3.1	0.0
1:15	30.0	13.3	80.0	21.6	37.2	6.7	9.6	1.8
1:20	20.0	13.7	59.7	26.8	46.5	12.5	10.0	18.3
Nymph predator								
1:5	60.0	25.0	75.0	60.0	100.0	10.0	5.0	0.0
1:10	80.0	15.0	59.1	10.6	60.0	16.2	7.5	2.5
1:15	13.3	20.0	75.4	17.5	42.7	20.0	7.7	9.7
1:20	57.5	28.7	65.0	20.3	41.0	31.0	17.4	7.5
Female predator								
1:5	70.0	20.0	100.0	25.0	70.0	20.0	5.0	5.0
1:10	40.0	17.5	38.8	31.8	69.4	0.0	5.6	8.1
1:15	25.0	35.0	96.6	36.6	37.2	27.0	13.5	10.0
1:20	21.2	21.2	62.7	58.1	54.9	16.2	27.0	13.1
Male predator								
1:5	30.0	75.0	70.0	25.0	75.0	20.0	0.0	5.0
1:10	17.5	30.0	47.3	2.5	43.4	2.5	5.6	0.0
1:15	21.6	13.3	10.0	5.0	30.3	0.0	8.1	8.8
1:20	11.2	2.5	63.6	40.8	26.8	7.5	7.6	9.6

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