BIOLOGY OF *EUSEIUS CONCORDIS* (CHANT) (ACARINA : PHYTOSEIIDAE) A PREDATOR OF THE TOMATO RUSSET MITE

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BIOLOGICAL CYCLES, OVIPOSITION RATES, UNDER LABORATORY CONDITIONS

SUMMARY : Some aspects of the biology of the predaceous mite *Euseius concordis* (Chant) were studied under laboratory conditions. Similar biological cycles and oviposition rates were observed when predator was fed *Aculops lycopersici* (Massee) or *Ricinus communis* L. pollen. On the average, *E. concordis* fed on 1.4 ± 0.3 active individuals of *A. lycopersici* per hour, spending about 55 ± 22 seconds on each. The activity of the predator was hindered by the webbing produced by *Tetranychus evansi* Baker & Pritchard.

CICLOS BIOLÓGICOS, ÍNDICES DE OVIPOSIÇÃO EM CONDIÇÕES DE LABORATÓRIO

RESUMO : Alguns aspectos biológicos do ácaro predator *Euseius concordis* (Chant) foram estudados em condições de laboratório. Ciclos biológicos e índices de oviposição similares foram observados quando o predador foi alimentado com *Aculops lycopersici* (Massee) ou polem de *Ricinus communis* L. Em média, *E. concordis* se alimentou de 1,4 ± 0,3 indivíduos de *A. lycopersici* por hora, gastando aproximadamente 55 ± 22 segundos alimentando-se de cada um. A actividade predatória do predador foi dificultada pela teia produzida por *Tetranychus evansi* Baker & Pritchard.

INTRODUCTION

Euseius concordis (Chant) belongs to the family Phytoseiidae, which contains some of the most important predators of phytophagous mites. This species was described for the first time based on material collected on citrus in Concórdia — Entre Rios — Argentina (CHANT, 1959). Later, the mite was recorded in Nicaragua, El Salvador (CHANT & BAKER, 1965), Paraguay (DENMARK & MUMA, 1970) and Brazil (DENMARK & MUMA, 1973), without any references as to its food habits. This is one of most common species in northeastern Brazil, associated with mites of the families Eriophyidae, Tetranychidae and Tenuipalpidae.

This study was conducted to observe some aspects of the biology of *E. concordis*, as this phytoseiid is often found in association with the tomato russet mite (*Aculops lycopersici* (Massee)), one of the main pests of tomato in Petrolina-PE, Brazil.

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METHODS AND MATERIALS

The study was conducted in the Laboratory of Entomology of the Agricultural Research Center for the Semi-Arid Tropics of Brazil (CPATSA) Brazilian Agricultural Research Corporation (EMBRAPA), Petrolina-Pernambuco, at 25 ± 4°C and 60 ± 14 % relative humidity.

The predator was reared on excised tomato leaves placed lower surface up, on a piece of polyurethane foam mat in a Petri dish. Each leaf was surrounded by a 1 cm wide border of wet cotton to prevent mites from escaping and to avoid leaf dehydration. The foam mat was watered daily ; consequently, the relative humidity in the mite microenvironment was higher than that in the laboratory. Mites were transferred to new leaves every third day.

Four kinds of food were tested : all stages of *Aculops lycopersici* (Massee) — Eriophyidae (tomato russet mite) ; all stages of *Tetranychus evansi* Baker & Pritchard — Tetranychidae (tomato red spidermite) ; a combination of all stages of *A. lycopersici* and *T. evansi* ; and *Ricinus communis* L. — Euphorbiaceae pollen (castorbean) extracted by the method described by MCMURTRY & SCRIVEN (1965 *b*). For the first three kinds of food, the rearing units consisted of tomato leaves already infested in the field by each of the respective species. For *R. communis* pollen, the rearing units were made of leaves free of individuals of both species, to which pollen was added every other day.

Only one individual was placed on each arena, except for the reproduction study, when a male and a female were maintained together continuously.

The average daily oviposition rate was calculated based on the total number of females present at the beginning of the observation period. Eggs oviposited during the first day of the test were not included in the calculation. Eggs were counted and removed from the arenas each day. The reproduction study was conducted with females obtained as follows. When food would be *A. lycopersici* or *R. communis* pollen, females had been reared from the egg stage on each of the respective kinds of food. On the other hand, when food would be *T. evansi* or a combination of *A. lycopersici* and *T. evansi*, females had been reared on *R. communis* pollen.

To observe prey consumption, 15 ovipositing females were isolated on excised tomato leaves heavily infested with all stages of *A. lycopersici*, and were observed for a 2.5 hr period under a dissecting microscope. Data were taken on the number of hosts fed upon and the mean time the predator spent feeding on each prey.

RESULT

■ *Development :* Table 1 shows the duration of the immature stages of *E. concordis* on each kind of food.

Both males and females showed approximately the same duration for each immature stage on either *A. lycopersici* or *R. communis* as food. The duration of ontogenesis was also approximately the same for both sexes, on both kinds of food.

None of 66 individuals fed all stages of *T. evansi* was able to reach the adult stage. About 70 % of the individuals died in the larval stage in the wet cotton surrounding the leaf, whereas

TABLE 1. Duration (in days) (± standard deviation) of the immature stages of *E. concordis* on *A. lycopersici* and *R. communis* pollen (25 ± 4°C, 60 ± 14 % RH).

Kinds of food	Sex	N° of individuals	Egg	Larva	Protonymph	Deutonymph	TOTAL
A. lycopersici	♀	29	1.5 ± .38	1.2 ± .41	1.0 ± .26	1.2 ± .49	5.0 ± .70
	♂	37	1.5 ± .44	1.0 ± .34	1.1 ± .51	1.2 ± .43	4.9 ± .84
R. communis	♀	12	1.6 ± .56	1.3 ± .33	1.2 ± .33	1.2 ± .33	5.3 ± .50
pollem	♂	8	1.5 ± .38	1.2 ± .37	1.1 ± .46	1.1 ± .18	5.1. ± .78

27 % developed to the protonymphal stage and then died in the same manner. Only 3 % reached the deutonymphal stage. Apparently, contact with the web produced by *T. evansi* is detrimental to immature stages of *E. concordis*, as the mites become uneasy whenever touching it, continuously rubbing palpi and legs against each other.

Of 34 mites fed the combination of *A. lycopersici* and *T. evansi* only four females and one male were able to develop from larvae to adults, in a period of about six days.

■ *Reproduction :* Table 2 shows the average daily rate of oviposition of *E. concordis* on each kind of food.

The oviposition rate on *A. lycopersici* was pratically the same as that on *R. communis* pollen.

TABLE 2. Average daily rate of ovipoditon of *E. concordis* (± standard deviation) on different foods (25 ± 4°C, 60 ± 14 % Rh).

Kinds of food	N° couples	Oviposition Rate *
A. lycopersici	14	1.7 ± .31
R. communis pollen	10	2.1 ± .40
T. evansi	21	.05 ± .17
A. lycopersici + *T. evansi*	15	.14 ± .18

* Based on 10 days of observation.

Only a few eggs were oviposited when *T. evansi* or a combination of *A. lycopersici* and *T. evansi* was offered as food. Only one of 21 individuals fed *T. evansi* was able to maintain oviposition for 10 days, laying a total of eight eggs, whereas only one of 15 individuals fed the combination of *A. lycopersici* and *T. evansi* was able to maintain oviposition for the same period, laying 6 eggs. Whenever *T. evansi* was present in the rearing unit, the female predator would walk only on the leaf veins or in the areas of the leaf free of webbing.

To obtain information on the total fecundity of *E. concordis*, a test was conducted with 14 pairs isolated on tomato leaves and fed all stages of *A. lycopersici*. The females had a pre-oviposition period of 0.8 ± 1.3 days, an oviposition period of 21.2 ± 8.3 days, and a post-oviposition period of 0.7 ± 1.0 days. The total fecundity averaged 33 ± 10 eggs.

■ *Prey consumption :* Short term constant observations showed that females of *E. concordis* were able to feed on any active stage of *A. lycopersici*. On the average, the predator fed on 1.4 ± 0.3 prey per hour, spending about 55 ± 22 seconds feeding on each one.

Observations also were made on the behavior of 7 ovipositing females placed in rearing units containing all stages of *T. evansi*, from which most of the webbing had been removed. Female *E. concordis* were observed to feed on eggs of the prey. They would occasionally chase prey larvae, but apparently were not prone to feed on them.

DISCUSSION

The duration of ontogenesis and the rate of oviposition of *E. concordis* fed *A. lycopersici* and *R. communis* pollen are similar to those reported for other species of the *finlandicus* group, to which *E. concordis* belongs. Some of the variations observed may be due to differences in experimental conditions utilized in the study of each species (ELBADRY, 1968 ; ELBADRY & ELBENHAWY, 1968 ; ELBADRY *et al.*, 1968 ; ELBENHAWY, 1975 ; MORAES & MCMURTRY, 1981). Several cases have been registered of eriophyids being utilized as prey by phytoseiids (MCMURTRY *et al.*, 1970). Some of these predators feed on eriophyids but do not readily reproduce or develop (MCMURTRY & SCRIVEN, 1964 *b* ; MCMURTRY & SCRIVEN, 1965 *a* ; SWIRSKI *et al.*, 1967 ; SWIRSKI & DORZIA, 1968). Others are known to feed and reproduce equally well on eriophyids and tetranychids (PUTMAN, 1962 ; BURREL & MCCORMICK, 1964 ; MCMURTRY & SCRIVEN, 1964 *a*), and still others can develop and reproduce better on eriophyids than on tetranychids (CHANT, 1959 ; BURREL & MCCORMICK, 1964).

E. concordis could not develop or reproduce well when *T. evansi* was offered as prey. The fact that the predator could not do well on *A. lycopersici* when the eriophyid was associated with

T. evansi in the same rearing unit suggests that the predator is disturbed by the webbind produced by the tetranychid. Extensive field observations had already shown the most common association of *E. concordis* was with mite species that produced little or no webbing (MORAES & MCMURTRY, unpublished data). It has been shown that the performance of phytoseiid species seems to be related to the pattern of distribution of their prey and to their dexterity on a webbed substrate. Some phytoseiids do better with heavily webbing tetranychids (HEBERT, 1959 ; BURREL & MCCORMICK, 1964 ; SMITH & STAFFORD, 1955 ; FLAHERTY, 1967 ; HOYT, 1969 *a, b* ; MUMA, 1955, 1958 ; DOSSE, 1958, 1967), whereas others prefer lightly webbing species (PUTMAN, 1962 ; MCMURTRY & SCRIVEN, 1964 *b*).

Under field conditions, it seems that the efficiency of *E. concordis* as a predator of *A. lycopersici* would be very low, since *A. lycopersici* and *T. evansi* occur side by side, on the same leaves, for most of the year.

REFERENCES

BURREL (R. W.) & MCCORMICK (W. J.), 1964. — *Typhlodromus* and *Amblyseius* (Acarina : Phytoseiidae) as predators on orchard mites. Ann. Ent. Soc. Amer., **57** : 483-487.

CHANT (D. A.), 1959. - Phytoseiid mites (Acarina : Phytoseiidae). Part II. A taxonomic review of the family Phytoseiidae, with descriptions of 38 new species. Can. Ent., Suppl., **12** : 45-166.

CHANT (D. A.) & BAKER (E. W.), 1965. — The Phytoseiidae (Acarina) of Central America. Mem. Ent. Soc. Can., **41** : 1-56.

DENMARK (H. A.) & MUMA (M. H.), 1970. — Some phytoseiid mites of Paraguay (Phytoseiidae : Acarina). Fla. Ent., **53** : 219-227.

DENMARK (H. A.) & MUMA (M. H.), 1973. — Phytoseiid mites of Brazil. Rev. Brazil. Biol., **33** : 235-276.

DOSSE (G.), 1958. — Uber einige neue Raubmilbenarten (Acarina : Phytoseiidae). Pflanzenschutzber, **21** : 44-61.

DOSSE (G.), 1967. — Schadmilben des Libanons und ihre Prädatoren. Z. ang. Ent., **59** : 16-48.

ELBADRY (E. A.), 1968. — Biological studies on *Amblyseius aleyrodis*, a predator of the cotton whitefly (Acarina : Phytoseiidae). Entomophaga, **13** : 323-329.

ELBADRY (E. A.) & ELBENHAWY (E. M.), 1968. — The effect of nonprey food, mainly pollen, on the development, survival, and fecundity of *Amblyseius gossipi* (Acarina : Phytoseiidae). Ent. Exp. & Appl., **11** : 269-272.

ELBADRY (E. A.), AFIFI (A. M.), ISSA (G. I.) & ELBENHAWY (E. M.), 1968. — Effect of different prey species on the development and fecundity of the predaceous mite, *Amblyeseius gossipi* (Acarina : Phytoseiidae). Z. ang. Ent., **62** : 247-251.

ELBENHAWY (E. M.), 1975. — Biology and feeding behaviour of the predatory mite, *Amblyseius brazilli* (Mesostigmata : Phytoseiidae). Entomophaga, **20** : 353-360.

FLAHERTY (D.), 1967. — The ecology and importance of spider mites on grapevine in the southern San Joaquim Valley, with emphasis on the role of *Metaseiulus occidentalis* (Nesbitt). Ph. D. Thesis, Un. Calif., Berkeley.

HERBERT (H. J.), 1959. — Note on feeding ranges of six species of predaceous mites (Acarina : Phytoseiidae) in the laboratory. Can. Ent., **91** : 812.

HOYT (S. C.), 1969 *a*. — Population studies of five mite species on apple in Washington. Proc. 2nd Intern. Congr. Acarology, Sutton-Bonnington, England (1967) : 117-133. Akad. Kiadó, Budapest.

HOYT (S. C.), 1969 *b*. — Integrated chemical control of insects and biological control of mites on apple in Washington. J. Econ. Ent., **62** : 74-86.

MCMURTRY (J. A.) & SCRIVEN (G. T.), 1964 *a*. — Biology of the predaceous mite *Typhlodromus rickeri* (Acarina : Phytoseiidae). Ann. Ent. Soc. Amer., **57** : 362-367.

MCMURTRY (J. A.) & SCRIVEN (G. T.), 1964 *b*. — Studies on the feeding, reproduction, and development of *Amblyseius hibisci* (Acarina : Phytoseiidae) on various food substances. Ann. Ent. Soc. Amer., **57** : 649-655.

MCMURTRY (J. A.) & SCRIVEN (G. T.), 1965 *a*. — Life history studies of *Amblyseius limonicus*, with comparative studies on *Amblyseius hibisci* (Acarina : Phytoseiidae). Ann. Ent. Soc. Amer., **58** : 106-111.

MCMURTRY (J. A.) & SCRIVEN (G. T.), 1965 *b*. — Insectary production of phytoseiid mites. J. Econ. Ent. **58** : 282-284.

MCMURTRY (J. A.), HUFFAKER (C. B.) & VAN DE VRIE (M.), 1970. — Ecology of tetranychid mites and their natural enemies : a review. I. Tetranychid enemies :

their biological characters and the impact of spray practices. Hilgardia, **40** : 331-390.

MORAES (G. J.) & MCMURTRY (J. A.), 1981. — Biology of *Amblyseius citrifolius* (Denmark & Muma) (Acarina : Phytoseiidae). Hilgardia, **49** : 1-29.

MUMA (M. H.), 1955. — Factors contributing to the natural control of citrus insects and mites in Florida. J. Econ. Ent., **48** : 432-438.

MUMA (M. H.), 1958. — Predators and parasites of citrus mites in Florida. Proc. 10th Intern. Congr. Ent., Montreal (1956) **4** : 633-647.

PUTMAN (W. L.), 1962. — Life history and behavior of the predaceous mite *Typhlodromus (T.) caudiglans* Schuster (Acarina : Phytoseiidae) in Ontario, with notes on the prey of related species. Can. Ent., **94** : 163-177.

SMITH (L. M.) & STAFFORD (E.M.), 1955. — Grape pests in California. Calif. Exp. Sta. Cir., **445** : 1-63.

SWIRSKI (E.), AMITAI (S.) & DORZIA (N.), 1967. — Laboratory studies on the feeding, development and reproduction of the predaceous mites *Amblyseius rubini* Swirski & Amitai and *Amblyseius swirskii* Athias (Acarina : Phytoseiidae) on various kinds of food substances. Israel J. Agr. Res., **17** : 101-119.

SWIRSKI (E.) & DORZIA (N.), 1968. — Studies on the feeding, development and oviposition of the predaceous mite *Amblyseius limonicus* Garman and McGregor (Acarina : Phytoseiidae) on various kinds of food substances. Israel J. Agr. Res., **18** : 71-75.

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