

BIOLOGY AND FEEDING BEHAVIOUR OF THE PREDATORY MITE, *AMBLYSEIUS SWIRSKII* (ACARI : PHYTOSEIIDAE)

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PREDATOR
LIFE CYCLE
TETRANYCHID
ERIOPHYID
POLLEN
AMBLYSEIUS
SWIRSKII

ABSTRACT : The predacious mite, *Amblyseius swirskii* Athias-Henriot completed its life cycle when fed on the tetranychid mite, *Tetranychus urticae* Koch, the eriophyid mite, *Eriophyes dioscoridis* Soliman and Abou-Awad, and pollen grains of *Ricinus communis* (L.) as an alternative food substance in the laboratory. The development was faster and reproduction was higher when *A. swirskii* fed on *E. dioscoridis*. The duration increased and reproduction decreased respectively when *A. swirskii* was fed on *R. communis*. The predator female consumed daily 15 and 125 individuals of *T. urticae* and *E. dioscoridis* respectively. The number of eggs deposited per day (3.0 eggs/♀/day) when fed on eriophyid mite, while feeding on the other prey and pollen grains were (1.7 eggs) respectively. Females neither fed nor reproduced on liquid nutrients.

PRÉDATEUR
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RÉSUMÉ : *Amblyseius swirskii* Athias-Henriot, accomplit complètement son cycle de vie en laboratoire, quand on le nourrit d'un tetranyque, *Tetranychus urticae* Koch, d'un eriophyide, *Eriophyes dioscoridis* Soliman et Abou-Awad, et comme substance alimentaire alternative, de grains de pollen de *Ricinus communis* (L.). *A. swirskii* se développe plus vite et sa reproduction est plus importante quand on le nourrit d'*E. dioscoridis*. Sur *R. communis* la durée du développement s'accroît tandis que le taux de reproduction décroît. Les femelles prédatrices consomment quotidiennement, respectivement 15 et 125 individus de *T. urticae* et de *E. dioscoridis*. Le nombre d'œufs déposés chaque jour quand le prédateur se nourrit de l'eriophyide est de 3.0 œufs par jour et par femelle, tandis qu'il n'est que de 1,7 œufs avec une autre proie ou des grains de pollen. Les femelles ne se sont ni nourries, ni reproduites avec des aliments liquides.

INTRODUCTION

The phytoseiid mite *Amblyseius swirskii* Athias-Henriot is an important natural enemy on apple trees, vineyards and mango orchards which are located at Katta village, Giza Province, Cairo. *A. swirskii* feeds not only on tetranychid mites and pollen grains, but also on coccids and mealybugs. (SWIRSKI *et al.* 1967a ; RAGUSA and SWIRSKI 1975, 1977 ; METWALLY *et al.* 1984). Some species of

Amblyseius can complete their life-cycle and reproduce more rapidly on pollen grains than on tetranychid mites (MCMURTRY and SCRIVEN, 1964 ; SWIRSKI *et al.*, 1967 ; DE MORAES and MCMURTRY, 1981). For some species of phytoseiids, eriophyid mites may be a more favorable food than tetranychids (CHANT, 1959 ; BURRELL and MCCORMICK, 1964 ; EL BANHAWY 1974 ; ABOU-AWAD and EL-BANHAWY 1986 ; ABOU-AWAD *et al.* 1989). It was felt that further studies of feeding habits of *A.*

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swirskii under laboratory conditions might provide a better understanding of its biology.

MATERIALS AND METHODS

Adult females of *A. swirskii* were collected from heavily infested grape, mango and apple leaves and transferred to the rearing substrates. Females were left for 24 hr, and their deposited eggs were used for the different biological tests. For the developmental studies, mulberry (*Morus alba*) leaf discs 1.5 cm diameter were placed in petridishes, upper surface downwards on water-saturated cotton wool. Eggs were transferred singly to the rearing discs, and the newly hatched larvae were supplied either with a known number of nymphs of the two spotted spider mite, *Tetranychus urticae* Koch, obtained from infested potato leaves in the laboratory, or the gall mite, *Eriophyes dioscoridis* Solomon & Abou-Awad obtained from infested galls of *Pluchea dioscoridis*. Other larvae were supplied with pollen grains of *Ricinus communis* (L.) as an alternative diet. Replace of the prey was carried out daily and records of development, food consumption and reproduction were recorded twice a day. To study the effect of various food substances on reproduction, gravid females were transferred singly to the petridish arenas and starved for 2 days. Each female was then supplied with the proper diet and records on reproduction and survival were taken for 10 successive days. Diets included natural prey (*T. urticae*, *E. dioscoridis*; pollen grains of *R. communis*); and liquid nutrients (honey, molasses). The experiments were conducted under laboratory conditions at $27 \pm 1^\circ\text{C}$ and 70-80 R.H.

RESULTS

A. swirskii was able to develop successfully from egg to adult on *T. urticae*, *E. dioscoridis*, or the pollen grains of *R. communis* (Table 1). Mating was essential to induce oviposition and frequent mating was important to complete reproduction. The total developmental period was shorter on eriophyid and tetranychid diets compared to that on pollen. The

preoviposition period likewise was shorter on the mite diets than on pollen (Table 2). The larvae was found to be a feeding stage, consuming an average of 0.4 tetranychids or 5 eriophyids per day respectively (see "Discussion").

Developmental stages	<i>T. urticae</i> (nymph) $\bar{x} \pm \text{S.E.}$	<i>E. dioscoridis</i> $\bar{x} \pm \text{S.E.}$	Pollen grains (<i>R. communis</i>) $\bar{x} \pm \text{S.E.}$
Nr. observations	22	28	26
Egg	2.59 ± 0.11	2.04 ± 0.04	2.73 ± 0.09
Larva	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00
Protonymph	$1.32 \pm 0.10a$	$1.39 \pm 0.09a$	$2.00 \pm 0.09b$
Deutonymph	$1.45 \pm 0.11a$	$1.25 \pm 0.08a$	$2.00 \pm 0.08b$
Total	$6.36 \pm 0.10a$	$5.71 \pm 0.12c$	$7.73 \pm 0.16b$

Different letters denote significant differences (F test, $P < 0.05$).

TABLE 1 : Average duration in days of the immature stages of *A. swirskii* at 27°C on test food substrates.

Period	Nr. obs.	<i>T. urticae</i> (nymph) $\bar{x} \pm \text{S.E.}$	<i>E. dioscoridis</i> $\bar{x} \pm \text{S.E.}$	Pollen grains (<i>R. communis</i>) $\bar{x} \pm \text{S.E.}$
Preoviposition	17	$1.41 \pm 0.12a$	$1.75 \pm 0.11a$	$2.13 \pm 0.26b$
Oviposition	17	$33.18 \pm 1.80a$	$25.62 \pm 2.28b$	$28.2 \pm 1.22b$
Adult	17	$48.06 \pm 1.47a$	$46.69 \pm 1.92a$	$35.53 \pm 0.96b$
Life span	17	$54.33 \pm 1.49a$	$52.44 \pm 1.96a$	$43.33 \pm 0.94b$

Different letters in a horizontal column denote significant differences (F test, $P < 0.05$).

TABLE 2 : Average duration in days of various periods of development of the adult female of *A. swirskii* at 27°C reared on test food substrates.

Oviposition period was shorter on *E. dioscoridis* than on *T. urticae* and pollen diets (significant at 5 % level). The prey consumption rate increased through the developmental stages, with the female consuming a daily average of 15 tetranychids or 125 eriophyids (Table 3). The highest rate of oviposition was reported on the eriophyid diet. Much lower rates were recorded on the tetranychid prey and pollen grains of *R. communis*. The duration of copulation for *A. swirskii* was relatively long (210-270 min).

Stage of <i>A. swirskii</i>	<i>T. urticae</i> (nymph) $\bar{x} \pm \text{S.E.}$	<i>E. dioscoridis</i> $\bar{x} \pm \text{S.E.}$
Larva	0.41 ± 0.15	5.17 ± 0.88
Protonymph	4.12 ± 0.19	34.17 ± 2.25
Deutonymph	6.82 ± 0.23	65.78 ± 2.27
Adult female	14.94 ± 0.22	124.78 ± 5.72

TABLE 3 : Consumption rate per day of *A. swirskii* on *T. urticae* and *diосcoridis* at 27°C .

The rate of reproduction of *A. swirskii* during 10 days was significantly higher on eriophyids than on tetranychids or pollen grains. Reproductive rate averaged 31, 17 and 17 eggs/female when fed on *E. dioscoridis*, *T. urticae* and pollen grains of *R. communis*, respectively. The addition of pollen to the eriophyid prey led to a considerable decrease in egg production (Table 4). Molasses, honey and plant leaf diets were unsuitable feeding and reproduction substrates. Individuals became cannibalistic during food shortage. In phytoseiids, the contents of the gut can be seen through the integument, and the coloration can indicate a specific food (ANDERSON and MORGAN 1956). The following colours were induced by the various diets : *T. urticae* : orange ; *E. dioscoridis* : whitish yellow ; pollen grains of *R. communis* ; pale yellow.

Type of food	Nr. of eggs laid per female					% surviving on 10 th day
	Nr. obs.	Max.	Min.	$\bar{x} \pm S.E.$		
<i>E. dioscoridis</i>	17	34	26	$30.71 \pm 0.57a$		100
<i>E. dioscoridis</i> and pollen (<i>R. communis</i>)	15	28	21	$23.07 \pm 0.50c$		100
<i>T. urticae</i> (nymph)	17	22	12	$16.76 \pm 0.87b$		100
<i>T. urticae</i> (nymph) and pollen (<i>R. communis</i>)	18	20	10	$15.06 \pm 0.59b$		100
Pollen (<i>Ricinus communis</i>)	15	23	11	$16.87 \pm 0.84b$		100
Molasses	12	0	0	0		50
Honey	12	0	0	0		70
Plant leaf	15	0	0	0		0

Means marked with the same letters are not significantly different (F. test, $P < 0.05$).

TABLE 4 : Oviposition rate of young *A. swirskii* on different food substances during 10 days at 27°C.

DISCUSSION

It is well known that members of the family Phytoseiidae show considerable variation in their feeding habits, including pollen grains, plant juices, moth eggs, and scale insects as well as phytophagous mites in their diet (CHANT 1959 ; McMURTRY *et al.*, 1970 ; TANIGOSHI 1982). Their dependence on animal food in the form of phytophagous mites varies considerably from species to species, mostly because of their innate characteristics but sometimes also perhaps due to the relative availability of different food sources in the environment.

Amblyseius swirskii was able to develop and reproduce on different preys and pollen grains. Larva moulted to protonymph with feeding. Obligatory predation in phytoseiid larvae has been reported before (DOSSE, 1958 ; McMURTRY and SCRIVEN, 1965 ; WATERS, 1955 ; ABOU-AWAD and EL-BANHAWY 1986 ; EL-BAGOURY and MOMEN 1989), but it is not common among the species studied to date.

Mating usually takes place immediately after final moult (EL-BADRY and EL BANHAWY, 1968 a, b ; EL-BANHAWY, 1975 ; AMANO and CHANT, 1978 ; HOY and SMILANICK, 1979). According to the classification of mating patterns proposed by AMANO and CHANT (1978 b), *A. swirskii* displayed the "*Amblyseius* type" of pre-mating behaviour, characterized by the male mounting the top of the dorsum of the female, prior to the establishment of the venter-to-venter mating position.

However, *A. swirskii* in the present study has one of the longest duration of mating, compared with other species studied such as *Phytoseiulus macropilis* (Banks) (PRASAD, 1967) and *Typhlodromus occidentalis* Nesbitt (LEE and DAVIS, 1968 ; LAING, 1969 ; HOY and CAVE, 1985). Soon after mating, the rate of predation of a predator female increased drastically. Adult female of *A. swirskii* consumed higher number of eriophyids and nymphs of tetranychid than did predatory nymph. These results coincide with those recorded by SABELIS (1985) who noted that egg production requires much food, not merely because of the number of eggs produced, but also due the amount of food invested per egg. Females of *A. swirskii* successfully developed from larva to adult when fed on pollen grains of *R. communis*. According to McMURTRY and SCRIVEN (1966), feeding on alternative foods may be a relative advantage for a predator in that it enables the predator to survive during critical periods when prey mites are not available, and also allow the population of predacious mites to increase to large numbers before those of the prey begin to build up. The ability of *A. swirskii* to develop, reproduce and survive on pollen grains was similar to that reported by EL-BADRY and EL-BANHAWY (1968 a, b) KINSLEY and SWIFT (1971) ; RASMY and EL BANHAWY (1975). ABOU-AWAD and EL BANHAWY (1986).

Laboratory tests on *A. swirskii* were conducted by RAGUSA and SWIRSKI (1975), who gave pollen from 17 kinds of weeds common in the citrus groves of Israel to the mites. A marked percentage of young reached maturity and the oviposition rate was moderate to high in some of them. According to SWIRSKI *et al.* (1967), the reproductive rate of *A. swirskii* on citrus pollen was low, although reproductivity on pollen of stone and pome fruits and on maize was high.

The honeydew excreted by coccids and mealybugs is favoured and utilized by various phytoseiids (HUFFAKER and KENNETT, 1956; CHANT and FLESCNER, 1960; McMURTRY and SCRIVEN, 1964 a, 1965), but its nutritional value is low. When offered honeydew of *Pseudococcus citriculus*, *A. swirskii* did not develop and oviposition was negligible (SWIRSKI *et al.*, 1967 a). Addition of honeydew of *Pseudococcus longispinus* to *Tetranychus cinnabarinus* raised the oviposition rate of *A. swirskii* (RAGUSA and SWIRSKI, 1977), it was also reported that crawlers of armoured scales and honeydew of the coccids and mealybugs serve only as survival food for this species.

Like other facultative predators, *A. swirskii* is able to prey and survive on different diets. The rate of reproduction was highly significant on eriophyids, and lower on tetranychids and pollen grains. Thus, the feeding on eriophyid mites increased female fecundity more than on tetranychids. Other studies have shown phytoseiid mites as major predators of eriophyids (McMURTRY and SCRIVEN, 1964; RASMY and EL BANHAWY, 1974; EASTERBROOK, 1982; ABOU-AWAD, 1983; ABOU-AWAD *et al.*, 1989).

Liquid diets such as honey and molasses were unsuitable for *A. swirskii* feeding and reproduction. Other predacious mites have not been successful on any tested artificial diets (SHEHATA and WEISMANN, 1972; KENNETT and HAMAI, 1980). Facultative phytophagy of some species of Phytoseiidae has been reported frequently (CHANT, 1959; CHANT and FLESCNER, 1960; KHAN, 1970). GILLIATT (1935) reported that *T. pomi* could be reared on plant materials alone. When the larvae of *A. swirskii* were reared on mulberry leaves without any diet, all were died before reaching deutonymphal

instar; also the gravid females stopped producing eggs when confined on the material alone.

These results from laboratory studies demonstrate the value of this type of research for understanding and projecting the outcome of predator/prey interactions for biological control.

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