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FEEDING HABITS, DEVELOPMENT AND OVIPOSITION OF THE PREDACIOUS MITE *AMBLYSEIUS SWIRSKII* ATHIAS-HENRIOT (ACARINA: PHYTOSEIIDAE) ON POLLEN OF VARIOUS WEEDS

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A B S T R A C T

Laboratory tests were conducted on ***Amblyseius swirskii*** Athias-Henriot fed pollen from 17 kinds of weeds common in the citrus groves of Israel. A marked percentage of young reached maturity and the oviposition rate was moderate to high on the following pollens: ***Stellaria media,***
Sonchus oieraceus, Capsella bursa pastoris, Raphanus raphanistrum, Sinapis arvensis. Euphorbia sp,, Mercurialis annua, Lamium amplexicaule, Oxaiis cernua. The nutritional value of the pollens from ***Senecio vernalis, Urtica urens*** and some other weeds was low.

INTRODUCTION

"Clean cultivation", as practiced in some citrus and avocado orchards in Israel, consists of destroying almost all weeds, mainly by herbicides. It was desirable to study the effect of weeds on the population of various natural enemies. Phytoseiid mites and parasites of ***Pseudococcus longispinus*** (Targioni-Tozzetti) (results to be published elsewhere) were chosen for this purpose.

Phytoseiid mites are widely distributed in the citrus groves of Israel; they prey on spider mites, eriophyids, flat mites and on some insects, which suggests their potential role

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1966; Muma, 1971; Nelson, 1973; Swirski, Amitai and Dorzia, 1967, 1970; Zaher and Shehata, 1971 and others). Yet no extensive work appears to have been published on the effect of weed pollen.
in biocontrol (Porath and Swirski, 1965). Many species of these predacious mites feed not only on animal matter, but also on pollen (Chant, 1959; Dosse, 1961; Elbadry and Elbenhawy, 1968; Kamburov, 1971; McMurty and Scriven, 1964,

The food habits of phytoseiids are variable and, as stated by Muma (1971), "certain species are predominantly pollenophagous, others are facultative predators that can either survive or reproduce on a variety of living and non-living organic materials and still others are obligatory predators." *Amblyseius swirskii* Athias-Henriot, serving as a model in this work, belongs to the second group. In laboratory studies the prey-animals *Tetranychus cinnabarinus* (Boisduval), *Eutetranychus orientalis* Klein, *Brevipalpus phoenicis* (Geijskes), *Phyllocoptruta oleivora* (Ashmead), *Bemisia tabaci* (Gennadius), *Retithrips syriacus* Mayet, and eggs of the moths *Prays citri* Millèr and *Ectomyelois ceratoniae* (Zeller) provided enough nutrition for the complete development of *A. swirskii* and for a medium to high oviposition rate. Percent survival of young stages and oviposition rate of females fed with the following pollens were very high: castor-bean, almond, maize, avocado, and *Carpobrotus edulis* (Swirski *et al.*, 1970).

A. swirskii was chosen for the present studies owing to its wide distribution and apparent importance as a natural enemy. In Israel it is dominant and abundant on citrus along the Coastal Plain (Porath and Swirski, 1965). It was also found on deciduous fruit trees, subtropical fruit trees, grape, vegetables, cotton, wild trees and shrubs, as well as on various annual and perennial plants (Swirski and Amitai, 1965; Wysoki and Swirski, 1971; Grinberg T., unpublished). *A. swirskii* is abundant in Egypt on grape, apple, quince, fig trees, and cotton (Elbadry and Khalil, 1972; Rasmy and Abou-Awad, 1972; Yousef and Shehata, 1971; Zaher and Shehata, 1971). It was also found in the Gaza strip and Sinai Peninsula (Wysoki and Swirski, 1971).

The major objectives of this study were: a) to obtain additional data on the feeding habits of phytoseiids; b) to study the nutritional value of pollens of various weeds, in order to make a preliminary evaluation of their potential role as food.

Laboratory tests were conducted during the winter and spring of 1972 on the development and oviposition rates of *A. swirskii* fed pollen from various weeds common to citrus groves growing in the Coastal Plain.

METHODS

All tests were made on black plastic plates, with water supplied by means of an absorbent cotton wick (Swirski *et al.*, 1970).

In the development studies each mite attaining adulthood was killed for sexing. For oviposition studies only young adults, one or two days old, were used. A dead male was replaced by a live one in order to obtain the full potential for copulation and oviposition. Conditions in the breeding room were 25°C and a relative humidity above 60%.

RESULTS

Post-embryonic survival

The effect of various pollens on post-embryonic survival is summed up in Table 1.

TABLE 1

Effect of various pollens on the post-embryonic suvival of *Amblyseius swirskii*. (Individuals that disappeared or entered the surrounding repellent were deducted from the percentage of young reaching maturity; number of tests: 5, 7* or 9**).

Pollen		Initial number of eggs	Number maturing ♀	♂	%
Aizoaceae	*Carpobrotus edulis*	25 (2)	21	2	100.0
Caryophyllaceae	*Stellaria media*	25 (1)	13	10	95.8
Compositae	*Bidens tripartita*	45** (21)	6	1	29.2
	Calendula arvensis	45** (5)	30	9	97.5
	Senecio vernalis	45** (16)	0	1	3.4
	Sonchus oleraceus	25 (0)	21	4	100.0
Cruciferae	*Capsella bursa pastoris*	25 (1)	18	6	100.0
	Raphanus raphanistrum	25 (4)	17	3	95.2
	Sinapis arvensis	35* (3)	25	6	96.8
Euphorbiaceae	*Euphorbia* sp.	25 (0)	19	6	100.0
	Mercurialis annua	25 (1)	16	8	100.0
Fumariaceae	*Fumaria* sp.	35* (2)	30	3	100.0
Geraniaceae	*Erodium romanum*	25 (0)	17	6	92.0
Labiatae	*Lamium amplexicaule*	25 (0)	18	6	96.0
Malvaceae	*Malva nicaensis*	25 (3)	10	3	59.1
Oxalidaceae	*Oxalis cernua*	25 (4)	19	2	100.0
Solanaceae	*Solanum villosum*	35* (3)	21	10	96.8
Urticaceae	*Urtica urens*	45** (23)	0	0	0

A high percentage of young mites reached maturity on the following pollens: *Carpobrotus edulis* (stored), *Stellaria media*, *Sonchus oleraceus*, *Capsella bursa pastoris*, *Raphanus raphanistrum*, *Sinapis arvensis*, *Mercurialis annua*, *Euphorbia* sp., *Lamium amplexicaule*, *Fumaria* sp., *Erodium romanum*, *Solanum villosum* and *Oxalis cernua*. Development lasted about 8-9 days and the mites looked fat. The nutritional value of pollens of either *Calendula arvensis* or *Malva nicaensis* was lower. Although 97.5% of the young mites reached maturity on the first-mentioned diet, the period of development lasted 19-29 days and the adult was small. When anthers of *Malva nicaensis* were offered as food, 59.1% of the young mites developed into adults after 16-24 days. A diet of *Bidens bipartita* was far from satisfactory, as only 29.2% of the mites reached maturity, their condition was poor, and their development lasted at least 18 days. On anthers of *Senecio vernalis* only one nymph turned into an adult, which died shortly afterwards; some young mites lived for 29 days without completing their development. On anthers of *Urtica urens* all larvae reached the protonymphal stage, a few attained the deutonymphal stage, and none reached adulthood. The young lived up to 26 days, were thin and in poor condition.

Oviposition rate

The effect of various kinds of pollen on the rate of oviposition and survival is shown in Table 2.

TABLE 2

Effect of various pollens on the oviposition rate and survival of *Amblyseius swirskii*. (Initial number of adults: 15 females, 5 males; number of tests: 5; duration of tests: 10-11 days).

Pollen		Number of adults surviving at end of test		Eggs / female /day
		♀	♂	
Aizoaceae	*Carpobrotus edulis*	15	4	0.40
Caryophyllaceae	*Stellaria media*	14	4	1.01
Compositae	*Bidens tripartita*	12	0	0
	Calendula arvensis	14	4	0.03
	Senecio vernalis	10	0	0
	Sonchus oleraceus	15	5	1.27
Cruciferae	*Capsella bursa pastoris*	15	5	0.57
	Raphanus raphanistrum	15	5	0.87
	Sinapis arvensis	14	5	0.99
Euphorbiaceae	*Euphorbia* sp.	15	5	0.63
	Mercurialis annua	15	5	1.33
Fumariaceae	*Fumaria* sp.	15	4	0.21
Geraniaceae	*Erodium romanum*	13	4	0.38
Labiatae	*Lamium amplexicaule*	15	5	0.67
Malvaceae	*Malva nicaensis*	15	0	0.04
Oxalidaceae	*Oxalis cernua*	12	5	1.05
Solanaceae	*Solanum villosum*	15	5	0.38
Urticaceae	*Urtica urens*	4	0	0
			S.E.	0.09

Differences larger than 0.09 eggs/female/day were significant at the 95% level.

On the following pollens the egg-laying rate was high, the mites were fat, and they were often seen ambulating between the anthers: *Stellaria media, Sonchus oleraceus, Sinapis arvensis, Mercurialis annua* and *Oxalis cernua*. Pollens of *Carpobrotus edulis* (unfresh), *Capsella bursa pastoris, Raphanus raphanistrum, Euphorbia* sp., *Fumaria* sp., *Erodium romanum, Lamium amplexicaule* and *Solanum villosum* were consumed readily by the mites, but the oviposition rate was moderate or low. The nutritional value of *Calendula arvensis* and *Malva nicaensis* was very low and the oviposition rate almost nil. On *Calendula arvensis* the survival of females and males was high, and they were fat. On *Malva nicaensis* the mites were fat, ambulated between the anthers supplied, but they were "nervous"; the survival of females was high and of males very low. No eggs were laid when pollens of *Urtica urens, Bidens tripartita* and *Senecio vernalis* were supplied. The death rate of males on these diets was very high, the females were thin and "nervous", and were often seen near the cotton wick or the barrier.

Muma (1971) divided candidate foods offered to various female phytoseiids in the laboratory into four categories: optimal, adequate, survival and inadequate foods. According to these criteria, pollens tested in the present work could be divided as follows: optimal foods- *Carpobrotus edulis, Stellaria media, Sonchus oleraceus, Capsella bursa pastoris, Raphanus raphanistrum, Sinapis arvensis, Euphorbia* sp., *Mercurialis annua, Lamium amplexicaule, Oxalis cernua;* adequate foods- *Fumaria* sp., *Erodium romanum, Solanum villosum;* survival food- *Senecio vernalis;* inadequate food- *Urtica urens*. Pollen of *Calendula arvensis* lies between the adequate and survival categories, whilst that of *Bidens tripartita* and *Malva nicaensis* lies between the survival and inadequate-food categories.

DISCUSSION AND CONCLUSIONS

Feeding and rapid multiplication of facultative predacious mites (like *Amblyseius hibisci* Chant or *A. swirskii*) on pollen may be a selective advantage for two reasons: (1) it enables them to survive during critical periods when prey-animals are not available or scarce; (2) the population of the predacious mites can increase to large numbers before those of the prey begin to build-up (McMurtry and Johnson, 1965; McMurtry and Scriven, 1966). In avocado orchards in California, pollen is considered to be one of the principal

factors influencing fluctuations in the population of *A. hibisci* (McMurtry and Johnson, 1965). In the vineyards of the San Joaquin Valley (California), tydeid mites thrive on wind-blown pollen of *Typha* and *Melaleuca*. Artificial dissemination of pollen raised the population levels of tydeid mites as well as of *Typhlodromus occidentalis* Nesbitt, which preys upon them. Consequently it was suggested that artificial dissemination of pollen or manipulation of a pollen-producing crop might correct the biological equilibrium of *Tetranychus pacificus* McGregor (Flaherty and Hoy, 1971).

From the standpoint of biocontrol, facultative predacious mites should not reject animal-prey in favor of pollen when both are present on the plants. In the laboratory and on avocado trees in the orchard, *Amblyseius hibisci* fed on both spider mites and pollen (McMurtry and Johnson, 1965; McMurtry and Scriven, 1964). However, as pollen was found to be a more favorable food than spider mites "therefore, even though prey consumption per individual would be less when pollen is available, the higher reproductive capacity induced by pollen feeding should result in a higher predator density, thus increasing the total number of prey destroyed by the species" (McMurtry and Scriven, 1966). In Nelson's studies (1973) the rates of development and oviposition of *A. hibisci* were raised when pollen was added to red spider mites in the diet. In the laboratory studies of *Amblyseius gossipi* Elbadry (in Egypt), a positive correlation was found between the rate of prey (*Tetranychus cinnabarinus*) consumption and the prey density in the presence or absence of maize pollen (Elbadry and Elbenhawy, 1968). Here, also, the predator did not reject the animal-prey in favor of pollen. At high prey densities pollen lowered prey consumption, on the one hand, but raised the oviposition rate, on the other. No detailed studies have been carried out on the effect of pollen on prey consumption by *A. swirskii*. Yet in laboratory observations this phytoseiid did not reject spider mites (such as *T. cinnabarinus* or *Eutetranychus orientalis* offered as candidate together with pollen (of maize or *Carpobrotus edulis*) (unpublished data).

A. swirskii inhabits both woody and herbaceous plants and has been found on the following grasses: *Althaea setosa, Asparagus* sp., *Erigeron crispus,* various Gramineae, *Polygonum equisetiforme* and *Solanum villosum* (Swirski and Amitai, 1965: Wysoki and Swirski, 1971). Thus, in citrus orchards, the

mite may feed upon the pollen of weeds, either while inhabiting these plants or whilst colonising trees (and getting drifted pollen).

Muma (1970) reported that the noncultivation of citrus orchards in Florida produced lower infestations of the spider mites *Panonychus citri* McGregor and *Eotetranychus sexmaculatus* Riley, but higher infestations of the citrus flat mite *Brevipalpus phoenicis*.

Our laboratory findings suggest that in a citrus grove pollen of weeds may provide a supplementary food for some phytoseiids (facultative predators), may encourage their build-up and raise their efficiency in the biocontrol of pests. Thus, clean-cultivation, at least from this point of view, seems to be undesirable; either partial natural weed growth or a cover-crop may serve as a tool in pest management. However, field experiments are required to test this contention.

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