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THE EFFECT OF *PHENACOCCUS MADEIRENSIS* GREEN (COCCOIDEA: PSEUDOCOCCIDAE) ON SOME BIOLOGICAL PARAMETERS OF FOUR SPECIES OF PHYTOSEIID MITES (PARASITIFORMES: PHYTOSEIIDAE)[1]

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ABSTRACT

The mealybug *Phenacoccus madeirensis* Green was supplied as prey to the following species of phytoseiid mites: *Euseius stipulatus* (Athias-Henriot), *Iphiseius degenerans* (Berlese), *Typhlodromus exhilaratus* Ragusa and *Typhlodromus ciyptus* Athias-Henriot in order to assay its effect on their postembiyonic development and oviposition rate. No young stages of the four species developed beyond the protonymph stage. Only very few eggs were laid by females of the four species. A list is provided with the results obtained while using other scale insect species, to show their importance for the survival of predaceous mites in the absence of optimal food.

KEY WORDS: Phytoseiidae, Pseudococcidae, postembryonic development, oviposition rate.

INTRODUCTION

Phytoseiid mites are important biological control agents of phytophagous mites. Many examples show the successes achieved using these predaceous mites in the field and greenhouses to control different phytophagous mites (McMurtry, 1982).

It is also known that most of them are facultative predators, which may develop and reproduce with success on various food substances (McMurtry and Scriven, 1966; Swirski et al., 1967a, b; Ragusa and Swirski, 1975; Pu et al., 1991), among which insects play also an important role. Of particular interest is the association of phytoseiid mites with scale insects.

During a survey on phytoseiid mites carried out in the surroundings of Palermo (Sicily) in May-July 1993, we found many specimens of *Iphiseius degenerans* (Berlese) and *Euseius stipulatus* (Athias-Henriot) associated with *Phenacoccus madeirensis* Green (Coccoidea: Pseudococcidae) living on *Eiythrina lantania* and *Acanthus* sp. Therefore it was decided to study the effect of the above-mentioned species on this mealybug. Moreover, as *Ph. madeirensis* also lives on citrus, we checked its influence on two other species of phytoseiid mites commonly found on citrus trees, namely *Typhlodromus exhilaratus* Ragusa and *T. cryptus* Athias-Henriot.

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MATERIALS AND METHODS

The mites *I. degenerans, E. stipulatus, T. exhilaratus* and *T. cryptus* were collected in the field and reared in the laboratory. Cages used for mass breeding were described by Swirski et al. (1967a); a mixture of pollen of *Carpobrotus edulis, Malephora* sp. and *Oxalis cernua* was supplied as food. Five eggs per cage (5 replicates) were used to determine the influence on postembryonic development; oviposition was checked observing 3 young females and 1 male per cage (5 replicates) for a period of 10 days; if males died, they were immediately substituted with other young males in order to provide the full potential for copulation and oviposition. Eggs and crawlers of *Ph. madeirensis* were field collected and supplied as needed.

Trials were carried out in an air conditioned room at 25 ± 1°C and 75 ± 5% RH. Observations were conducted daily almost at the same hour.

RESULTS AND DISCUSSION

The stages of *Ph. madeirensis* supplied had, in all cases, a negative influence on the postembryonic development (Table 1), as no immatures of the four mite species attained adulthood. Only larvae, which molted to protonymphs and died within approximately four days, were obtained. *E. stipulatus* had the highest larval mortality (88%) and *T. cryptus* the lowest (8%). Even if larvae and protonymphs were seen moving around the food and grasping it with their legs, we did not observe any predation. Larvae of *T. exhilaratus* do not feed (Ragusa, 1979), and probably the same happens with the other larvae, but further observations are required. A cannibalistic behavior was observed for *E. stipulatus.* All immatures were in poor conditions, thin, and mostly found on the surrounding cotton wool supplying water.

TABLE 1

Effect of eggs and crawlers of *Phenacoccus madeirensis* Green on postembryonic development of *Typhlodromus exhilaratus* Ragusa, *Typhlodromus cryptus* Athias-Henriot, *Euseius stipulatus* (Athias-Henriot) and *Iphiseius degenerans* (Berlese)

Phytoseiids	Initial number of eggs	Mortality (%)				Attaining adulthood	Duration of protonymphal stage (days)
		Eggs	Larvae	Proto-nymphs	Deuto-nymphs		
T. exhilaratus	25	0	16	84	0	0	3.7
T. cryptus	25	0	8	92	0	0	4.2
E. stipulatus	25	0	88	12	0	0	3.8
I. degenerans	25	0	43	57	0	0	3.6

The value of the food supplied for oviposition proved to be very low (Table 2). The highest oviposition was obtained with *T. cryptus* (0.38 eggs/female/day), but it was almost nil for the other species. Eggs were laid between the second and the fourth day.

No adults of *E. stipulatus* and *I. degenerans* survived at the end of the experiment; mortality was low for *T. exhilaratus* (20%) and higher for *T. cryptus* (46.6%).

TABLE 2
Effect of eggs and crawlers of *Phenacoccus madeirensis* Green on the oviposition rate and survival of *Typhlodromus exhilaratus* Ragusa, *Typhlodromus cryptus* Athias-Henriot *Euseius stipulatus* (Athias-Henriot) and *Iphiseius degenerans* (Berlese)

Phytoseiids	Number of adults		Number of adults surviving at the end of the test		Mortality		Eggs/ female/ day
	Females	Males	Females	Males	Females	Males	
T. exhilaratus	15	5	12	1	20	80	0.11
T. cryptus	15	5	8	1	46.6	80	0.38
E. stipulatus	15	5	0	0	100	100	0.10
I. degenerans	15	5	0	0	100	100	0.08

It is known that some mites feed upon scale insects: species belonging to the genus *Hemisarcoptes* have been used in the biological control of armored scale insects (Gerson et al., 1990). Studies were conducted to evaluate the impact of *Hemisarcoptes* on host scales (Gerson and Schneider, 1981). More recently the potential of *Hemisarcoptes coccophagus* Meyer in controlling the kiwi pest *Hemiberlesia lataniae* (Signoret) was shown after its introduction into New Zealand (Hill et al., 1993).

As far as phytoseiid mites are concerned, many studies were carried out to assay the influence of various stages of different scale insects on their postembryonic development and oviposition rate.

In Table 3 we summarized results obtained by various authors using different species of phytoseiid mites. The results are controversial as the influence was sometimes positive and in other cases negative; when California red scale *Aonidiella aurantii* (Maskell) was used, the influence on postembryonic development was positive and the percentages of adults obtained ranged from 38 to 100%. Immatures of *Amblyseius limonicus* (Garman and McGregor) feeding on crawlers and honeydew of *Pseudococcus* aff. *citriculus* Green reached adulthood in 26.3% cases. Only 16% immatures of *Amblyseius andersoni* (Chant) fed crawlers of *Saissetia oleae* (Olivier) reached adulthood. No other scale insects had a positive influence on the postembryonic development: usually it was nil or very poor (0–4.8%).

The influence of scale insects on oviposition was similar to that on postembryonic development; this was the case with *Aonidiella aurantii*. Sometimes the effect was more positive on oviposition rate than on postembryonic development. This was the case of *Amblyseius swirskii* (Athias-Henriot) which laid 1.11 eggs/female/day, while 38.2% of its immatures reached adulthood. Generally speaking, other scales such as *Ceroplastes floridensis* Comstock, *Pseudococcus* aff. *citriculus, Coccus hesperidum* Linnaeus, *Saissetia oleae* (Olivier), *S. coffeae* (Walker), *Pseudococcus longispinus* (Targioni Tozzetti), *Icerya purchasi* Maskell and *Phenacoccus madeirensis* did not influence oviposition positively, as the number of eggs was almost nil.

Muma (1971) reviewed the food habits of phytoseiid mites, classifying foods in four categories in relation to the influence they had on postembryonic development and oviposition rate, as follows: (1) optimal, (2) adequate, (3) survival, (4) inadequate. Using this classification,

TABLE 3

Some reported data on the postembryonic development and oviposition rate of various species of phytoseiid mites feeding on different scale insects under laboratory conditions

Phytoseiids	Hosts		Attaining adulthood (%)	Eggs/ female/ day	References
T. rickeri	*Hemiberlesia lataniae*	eggs and crawlers	–	low	McMurtry, 1963
A. limonicus	*Hemiberlesia lataniae*	eggs and crawlers	–	0.6	McMurtry, 1963
	Aonidiella aurantii	crawlers	85.7	–	Swirski and Dorzia, 1968
	Pseudococcus aff. *citriculus*	crawlers and honeydew	26.3	0.23	Swirski and Dorzia, 1968
E. hibisci	*Hemiberlesia lataniae*	eggs and crawlers	–	0.4	McMurtry, 1963
	Aonidiella aurantii	crawlers	78.2	0.7	Swirski et al., 1970
A. chilenensis	*Ceroplastes floridensis*	crawlers and honeydew	0	–	Swirski et al., 1970
	Aonidiella aurantii	crawlers	88.9	0.53	Swirski et al., 1970
Metaseiulus occidentalis	*Ceroplastes floridensis*	crawlers and honeydew	0	0	Swirski and Dorzia, 1969
	Aonidiella aurantii	crawlers	79.2	0.57	Swirski and Dorzia, 1969
	Hemiberlesia lataniae	eggs and crawlers	–	0.25	McMurtry, 1963
T. athiasae	*Aonidiella aurantii*	crawlers	100	0.86	Swirski et al., 1967b
	Pseudococcus aff. *citriculus*	crawlers and honeydew	0	–	Swirski et al., 1967b

A. swirskii	*Aonidiella aurantii*	crawlers
	Pseudococcus aff. *citriculus*	crawlers and honeydew
	Coccus hesperidum	crawlers
	Coccus hesperidum	crawlers and honeydew
	Saissetia oleae	crawlers
	Saissetia oleae	eggs and crawlers
	Saissetia oleae	crawlers and honeydew
	Saissetia oleae	eggs, crawlers and honeydew
	Saissetia coffeae	eggs
	Saissetia coffeae	eggs, crawlers and honeydew
	Pseudococcus aff. *citriculus*	crawlers and honeydew
	Pseudococcus longispinus	crawlers and honeydew
E. rubini	*Aonidiella aurantii*	crawlers
	Pseudococcus aff. *citriculus*	crawlers and honeydew
A. andersoni	*Saissetia oleae*	eggs and crawlers
	Icerya purchasi	eggs and crawlers
T. exhilaratus	*Phenacoccus madeirensis*	eggs and crawlers
T. cryptus	*Phenacoccus madeirensis*	eggs and crawlers
E. stipulatus	*Phenacoccus madeirensis*	eggs and crawlers
I. degenerans	*Phenacoccus madeirensis*	eggs and crawlers

38.2	1.11	Swirski et al., 1967a
0	0.01	Swirski et al., 1967a
0	0	Ragusa and Swirski, 1977
0	0.02	Ragusa and Swirski, 1977
0	0	Ragusa and Swirski, 1977
4.8	0	Ragusa and Swirski, 1977
4.2	0	Ragusa and Swirski, 1977
0	0	Ragusa and Swirski, 1977
0	0	Ragusa and Swirski, 1977
0	0	Ragusa and Swirski, 1977
0	0	Ragusa and Swirski, 1977
4.2	0	Ragusa and Swirski, 1977
71.4	0.48	Swirski et al., 1967a
0	0.13	Swirski et al., 1967a
16	0.01	Ragusa Di Chiara and Tsolakis, 1994
0	0	Ragusa Di Chiara and Tsolakis, 1994
0	0.11	Present paper
0	0.38	Present paper
0	0.1	Present paper
0	0.08	Present paper

we may consider most scales as either adequate or survival foods, and few of them as inadequate. But even if the nutritional value of scale insects is inconclusive, they can still be used by phytoseiid mites during periods when the optimal food is absent to maintain a population which will increase as soon as better nutrients appear again. Moreover, phytoseiid mites can also find overwintering shelter under scale covers. Such behavior explains why many mites are often found under scale covers even if the species has no positive influence on the predaceous mites. These could account for the cases reported by Putman (1962) and by Lal and Naji (1980); the latter found 10–15% of scales with phytoseiid mites during winter.

In conclusion, the reason why we found many specimens of *E. stipulatus* and *I. degenerans* associated with *Ph. madeirensis* during May–July must still be elucidated.

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