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A FIVE YEAR STUDY ON POPULATION FLUCTUATIONS
OF PHYTOSEIID MITES IN A CITRUS ORCHARD IN SICILY*

BY S. RAGUSA** ***

ABSTRACT : From 1979 to 1984 a study was carried out in a citrus orchard in the
surroundings of Palermo (Italy), in order to ascertain both the species of phyto­
phagous and phytoseiid mites associated with citrus trees, and their fluctuations in
populations. Two species of phytophagous mites were found : the two-spotted
spider mite, *Tetranychus urticae* Koch, and the citrus bud mite, *Eriophyes sheldoni*
Ewing. Eighteen species of phytoseiid mites were collected, the most dominant
being *Amblyseius stipulatus* Athias-Henriot. It was followed by five more fre­
quent species such as *Typhlodromus rhenanoides* Athias-Henriot, *Typhlodromus
exhilaratus* Ragusa, *Typhlodromus athenas* Swirski & Ragusa, *Typhlodromus
cryptus* Athias-Henriot, and *Seiulus amaliae* Ragusa & Swirski ; the remaining
species were seldom collected. Population of *A. stipulatus* usually showed peaks
during summer months ; ebbs were inconsistent. Population of other phytoseiids
were almost always at a lower leve!. Sometimes population of *A. stipulatus*
showed a breakdown apparently due to special climatic conditions, such as "scirocco"
(a hot wind from Africa). Population of *T. urticae* was scarce ; population of *E. shel­
doni* was sometimes present to some extent.

RIASSUNTO : Dal 1979 al 1984 è stata condotta una ricerca in un agrumeto nei
dintorni di Palermo, allo scopo di accertare le specie di acari fitofagi e acari preda­
tori della famiglia Phytoseiidae, associate agli agrumi, nonché le loro fluttuazioni
di popolazione. Tra i fitofagi si sono riscontrati : *Tetranychus urticae* Koch ed
*Eriophyes sheldoni* Ewing. Per quanto riguarda i fitoseidi, ne sono state censite
18 specie, di cui *Amblyseius stipulatus* Athias-Henriot è stata la più comune. Tale
specie è stata seguita da *Typhlodromus rhenanoides* Athias-Henriot, *Typhlodromus
exhilaratus* Ragusa, *Typhlodromus athenas* Swirski & Ragusa, *Typhlodromus
cryptus* Athias-Henriot e *Seiulus amaliae* Ragusa & Swirski. Le restanti specie sono
state raccolte sporadicamente. La popolazione di *A. stipulatus* ha presentato picchi
durante i mesi estivi, e si è sempre mantenuta a livelli superiori rispetto a quelle
degli altri fitoseidi. Alcune volte, a causa probabilmente di particolari condizioni
climatiche, spesso quando soffia lo scirocco, la popolazione di tale predatore
ha subito notevoli abbassamenti. Per quanto riguarda i fitofagi, la popolazione di
*T. urticae* è stata insignificante, mentre quella di *E. sheldoni* è stata talvolta più
elevata.

* The present paper is dedicated to my father (1913-1983) : ad memoriam.
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*** Supported by funds from Ministero della Pubblica Istruzione (40 %).

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INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae* Koch, the citrus red mite, *Panonychus citri* (McGregor), the citrus bud mite, *Eriophyes sheldoni* Ewing, and the pink citrus rust mite, *Aculops pelekassi* (Keifer) are the most important phytophagous mites associated with citrus trees in Sicily. They are generally controlled by chemicals. Associated with phytophagous mites there are usually predaceous mites belonging to the family *Phytoseiidae*; their importance has been pointed out and summarised by McMURTRY, HUFFAKER and VAN DE VRIE (1970).

As very little information is available in Italy on such predaceous mites, studies were carried out to get a deeper knowledge on them and to try their use in control practices. Studies aimed at ascertaining the following aspects: a) species of phytoseiid mites inhabiting citrus trees; b) phenology and dynamics of phytoseiid mites; c) fluctuations in populations of phytophagous mites.

Studies were carried out from 1979 to 1984.

MATERIALS AND METHODS

The citrus orchard was situated in Termini Imerese (Palermo) at about 100 m. above sea level; no chemicals had been sprayed there for at least ten years.

Phytoseiids were collected in field from 15 random selected trees, by shaking 20 twigs per tree; mites were preserved in alcohol, cleared, mounted and checked under a phase contrast microscope. All post-embryonic stages were taken into account to observe the population composition; females were checked to ascertain the presence of ripe eggs inside their bodies and the presence of spermatophores or residues of spermatophores in their insemination apparatus. As regards phytophagous mites, five young twigs per tree, out of the above mentioned trees, were collected. Presence of *T. urticae* was ascertained by checking 5-10 leaves per twig under a stereomicroscope. *E. sheldoni* was checked by dissecting 5 subapical buds per twig. Sampling was weekly done; we recorded temperatures and rainfalls in the orchard.

RESULTS AND DISCUSSION

All the species of phytoseiid mites found on citrus trees in Sicily during 1972-1984, are reported in table 1. Among them *Amblyseius stipulatus* Athias-Henriot is the dominant species. Others such as *Typhlodromus rhenanoides* Athias-Henriot, *Typhlodromus cryptus* Athias-Henriot, *Typhlodromus athenas* Swirski & Ragusa, *Typhlodromus exhilaratus* Ragusa, and *Seiulus amalai*e Ragusa & Swirski, are frequent; the remaining species were collected in few specimens and only sporadically.

Fig. 1 shows the weekly population fluctuations of *A. stipulatus* and of all the other phytoseiid mites as well as the trends of temperatures (minimum and maximum), and rainfalls. The figure shows that peaks usually occurred in June-July.

<table>
<thead>
<tr>
<th>Table 1 : Phytoseiid species collected on citrus trees in Sicily during 1972-1984.</th>
</tr>
</thead>
<tbody>
<tr>
<td>*** AMBLYSEIUS STIPULATUS* Athias-Henriot</td>
</tr>
<tr>
<td>** TYPHLODROMUS CRYPTUS Athias-Henriot</td>
</tr>
<tr>
<td>** TYPHLODROMUS ATHENAS Swirski &amp; Ragusa</td>
</tr>
<tr>
<td>** TYPHLODROMUS RHENANOIDES Athias-Henriot</td>
</tr>
<tr>
<td>** TYPHLODROMUS EXHILARATUS Ragusa</td>
</tr>
<tr>
<td>** SEIULUS AMALAI*e Ragusa &amp; Swirski</td>
</tr>
<tr>
<td>* AMBLYSEIUS POTENTILLAE* (Garman)</td>
</tr>
<tr>
<td>* AMBLYSEIUS ITALICUS* (Chant)</td>
</tr>
<tr>
<td>*** very frequent</td>
</tr>
<tr>
<td>** frequent</td>
</tr>
<tr>
<td>* only few</td>
</tr>
<tr>
<td>* AMBLYSEIUS FINLANDICUS s.l. Oudemans</td>
</tr>
<tr>
<td>* KAMPIMODROMUS ABERRANS s.l. Oudemans</td>
</tr>
<tr>
<td>* IPHYSEIUS DEGENERANS* (Berlese)</td>
</tr>
<tr>
<td>* PHYTOSEIULUS PERSIMILIS* Athias-Henriot</td>
</tr>
<tr>
<td>* PHYTOSEIUS FINITIMUS Ribaga</td>
</tr>
<tr>
<td>* PHYTOSEIUS PANORMITA* Ragusa &amp; Swirski</td>
</tr>
<tr>
<td>* TYPHLODROMUS sp.</td>
</tr>
<tr>
<td>* TYPHLODROMUS PHIALATUS* Athias-Henriot</td>
</tr>
</tbody>
</table>

1. Our survey on phytoseiid mites on citrus had started in 1972.
with the only exception of 1981 when the peak appeared later, in October; on the other hand ebbs were inconsistent. In fact in 1979-1980 ebbs were in January-February, during May in 1981, in April in 1982, and in July in 1983. It should be mentioned that in July 1980 the population showed a sudden strong drop; from that time onwards the population remained at a very low level. Another collapse of population happened at the end of July 1982 and lasted two months. As far as these sudden collapses are concerned, we see from fig. 1 that they are apparently connected with temperature. In fact temperatures above 40°C and lasting more than four hours, had a negative influence on the population of *A. stipulatus*. This happened in 1980 when “scirocco”, a hot wind which blows strongly from Africa, caused a clear drop of population. This fact was also confirmed in 1982, when in June, there were two days of scirocco with temperatures above 40°C, which lasted eight hours on the first day, and six hours on the second day, and caused a similar collapse of population. On the other hand, temperatures inferior to 40°C, though having a negative influence on population, did not cause any similar collapse. In fact in 1979, 1981, 1983, when the highest temperatures were 38°C in August, 35°C in July, and 39°C in July again, respectively, we did not register any collapse.

On the other hand, winter temperatures which sometimes reached 0°C (as in February 1981, when the temperature of 0°C held for about five hours), slowed the population development. If, on the contrary, autumn and winter temperatures were warm, as during 1981, 1982 and 1983, the population grew and the warm temperature most probably explains the high level of population during these periods.

Maximum rainfalls in Sicily are usually concentrated during autumn and winter, with few rainfalls in spring and generally drought in summer. If rainfalls are not continuous, they exert only a mechanical, washing away action on the population of *A. stipulatus*, and as a matter of fact, after a few days, population is abundant again. It should be pointed out that according to Poë and Enns (1969), rainfalls cause a big loss of population of phytoseiids preying upon web-forming hosts. As regards the fluctuations of all the other phytoseiid populations, the curve was always at lower levels than that of *A. stipulatus*. Only during winter and spring 1981, their populations reached quite high levels, exceeding sometimes that of the predominant species. In late summer and in autumn, however, population of *A. stipulatus* became predominant again, while the other populations diminished. Fig. 2 focuses on the five most important species of phytoseiid mites, and gives a more detailed idea of their monthly fluctuations. During the first two years the five population curves had almost the same low trends. From the beginning of 1981 these populations started growing up; the largest population was reached by *T. rheanoides* with peaks during the summer months, followed by *T. exilatus*, while the other species remained at lower levels. During autumn and winter, populations of all the five species diminished, but population of *T. rheanoides* was still the most pronounced one in comparison with the other four species. Unfortunately we have no explanations for the predominance of such a species.

As far as other species are concerned, *Phytoseius finitimus* Ribaga was found in July 1980, from April to September 1981 and in January and March 1982; it was more frequent during the summer months; *Iphiseius degenerans* (Berlese) was collected from April 1981 to March 1982, but it was more abundant during September-October; *Kampimodromus aberrans* Oudemans s.l., was found in a small number throughout the whole year; *Typhlodromus* sp. was only found during spring 1979 and spring-winter 1980; the remaining species were sporadically collected, as it follows: *Amblyseius italicus* (Chant) — January 1981; *Phytoseius persimilis* Athias-Henriot — June 1979; *Typhlodromus phialatus* Athias-Henriot — April 1981; *Amblyseius potentillae* (Garman) — March 1981.

*Amblyseius stipulatus* is a wide-spread species associated with citrus trees. It was found in Greece (Swirscki & Ragusa, 1976), Yugoslavia (Mijuskovic & Tomasevic, 1975), Turkey, Spain (McMurtry, 1977), Algeria (Athias-Henriot, 1960), Italy
Fig. 2: Fluctuations in populations of other common species of phytoseiid mites during February 1979-March 1984.
(Ragusa, 1977), in almost all the Mediterranean regions, but neither in Israel (Porath & Swirski, 1965), nor in Lebanon (Dosse, 1967). It was also introduced in California and there established (McMurtry, 1977). It was found in field associated with, and preying upon, P. citri and T. cinabarinus (Boisduval); moreover, from laboratory trials carried out by McMurtry (1977), it resulted that A. stipulatus, fed both on spider mite and pollen, developed very well.

As regards T. exhilaratus, this species found in Sicily (Ragusa, 1977), Greece (Swirski & Ragusa, 1977), and in Israel (Swirski's personal communication), was collected on citrus trees associated with, and preying upon, T. urticae and P. citri. Moreover, according to our laboratory trials on its food habits (Ragusa, 1979), T. exhilaratus developed well on preys such as T. urticae and P. citri, and on pollens. Apparently there are no data about the diets of the other more frequent species.

Since A. stipulatus is the predominant species in our citrus orchards, studies were also carried out on its overwintering. The composition of A. stipulatus population during five years, is reported in fig. 2. It can be seen that A. stipulatus is an active species during winter; as a matter of fact, during this season it is possible to find adults of both sexes and young stages in different percentages; the number of young stages starts increasing in March. These findings are generally supported by the data given in table 2. It results from this table that in winter a pronounced number of females have ripe eggs inside their bodies or show the presence of spermaphores or residues of spermaphores in the insemination apparatus. The percentage of females with unfertilized insemination apparatus is usually very low.

As regards overwintering, A. stipulatus behaves like other phytoseiid mites from warm countries, which usually are present as females, males, and young stages throughout winter as i.e. Amblyseius peregrinus (Muma) (Muma, 1955), Amblyseius hibisci Chant and Amblyseius limonicus Garman & McGregor (McMurtry & Johnson, 1965), Amblyseius swirskii Athias-Henriot, Amblyseius

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**Fig. 3**: Composition of population of *Amblyseius stipulatus* Athias-Henriot during February 1979-March 1984.
Table 2: Presence of ripe eggs, spermatophores and residues of spermatophores in females of *Amblyseius stipulatus* Athias-Henriot during February 1979-March 1984.

<table>
<thead>
<tr>
<th>MONTH</th>
<th>WITH EGGS %</th>
<th>WITHOUT SPER.</th>
<th>WITH EGGS %</th>
<th>WITHOUT RES.</th>
<th>WITH EGGS %</th>
<th>WITHOUT RES.</th>
<th>WITH EGGS %</th>
<th>WITHOUT RES.</th>
<th>WITH EGGS %</th>
<th>WITHOUT RES.</th>
<th>WITH EGGS %</th>
<th>WITHOUT RES.</th>
<th>TOTAL NO. EXAMINED</th>
<th>WITH EGGS %</th>
<th>WITHOUT SPER.</th>
<th>WITH EGGS %</th>
<th>WITHOUT RES.</th>
<th>WITH EGGS %</th>
<th>WITHOUT RES.</th>
<th>TOTAL NO. EXAMINED</th>
<th>WITH EGGS %</th>
<th>WITHOUT SPER.</th>
<th>WITH EGGS %</th>
<th>WITHOUT RES.</th>
<th>WITH EGGS %</th>
<th>WITHOUT RES.</th>
<th>TOTAL NO. EXAMINED</th>
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<td>23.4</td>
<td>28.2</td>
<td>23.4</td>
<td>28.2</td>
<td>23.4</td>
<td>28.2</td>
<td>23.4</td>
<td>28.2</td>
<td>23.4</td>
<td>28.2</td>
<td>23.4</td>
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<td>+</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>+</td>
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<td>4</td>
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<td>26.0</td>
<td>32.0</td>
<td>26.0</td>
<td>32.0</td>
<td>26.0</td>
<td>32.0</td>
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<td>92</td>
<td>1.0</td>
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<td>+</td>
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<td>+</td>
<td>6</td>
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<td>6</td>
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<td>8</td>
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<td>0</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>12</td>
<td>179.0</td>
<td>21.5</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1074</td>
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<tr>
<td>DEC.</td>
<td>29.5</td>
<td>9.2</td>
<td>29.5</td>
<td>9.2</td>
<td>29.5</td>
<td>9.2</td>
<td>29.5</td>
<td>9.2</td>
<td>29.5</td>
<td>9.2</td>
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<td>142</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>1</td>
<td>24.1</td>
<td>106.0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig. 4: Fluctuations in populations of the two-spotted spider (*Tetranychus urticae* Koch) and of the citrus bud mite (*Eriophyes she/ldoni* Ewing).

rubini Swirski & Amitai, *Typhlodromus athiasae* Porath & Swirski (WYSOKI & SWIRSKI, 1971), and not like phytophagids from temperate and cold countries such as *Typhlodromus pyri* Scheuten (CHANT, 1959), and *Amblyseius cucumeris* (Oudemans) (DOSSE, 1955). It should, however, be mentioned that in warm countries some species such as *Amblyseius judaicus* Swirski & Amitai (WYSOKI & SWIRSKI, 1971), have also diapausa during winter. As regards other species of phytophagids, we have no sufficient data for a good evaluation of their overwintering. However, in winter we found males and a few young stages of *T. rhenanoides*, *T. cryptus* and *I. degenerans* (this last species behaving as in Israel, WYSOKI & SWIRSKI, 1971), so that these three species are
apparently active the whole year around. Additional data should be collected before drawing a final conclusion. Trends of infestation of the phytophagous mites *T. urticae* and *E. sheldoni* are shown in fig. 4. As it appears, *T. urticae* population was almost absent. *E. sheldoni* was present in 1980 with moderately low population which grew up in 1981 and reached the highest peak in January 1982.

We have no data on the relationship between *A. stipulatus* and *E. sheldoni*, and to the best of our knowledge, no tests have been carried out, even though they would certainly be worthwhile. We can therefore summarise from our five year study:

a) 18 species of phytoseiid mites were collected on citrus trees, but the predominant species was *A. stipulatus*;

b) population of *A. stipulatus* usually reached peaks during the summer months, whilst ebbs were inconsistent as they changed each year;

c) high temperatures, above 40°C lasting for about four hours, especially when "scirocco" blew, had a detrimental effect on population;

d) *A. stipulatus* is an active species throughout winter and it has no diapause;

e) populations of other phytoseiids were always at lower levels than that of *A. stipulatus*; these could sometimes exceed that of *A. stipulatus*, but only for a limited amount of time;

f) as far as phytophagous mites are concerned, only population of *E. sheldoni* was present to any extent, but we have no data on the relationship between this species and *A. stipulatus*.

KEY-WORDS: Italy, phytoseiid mites, phytophagous mites, citrus, phenology.

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I want to express my gratitude and my deepest thanks to Prof. E. SWIRSKI for his useful advice and for his critical comments on the manuscripts. Particular thanks are also due to Dr. G. ROMANO, who allowed us to carry out our study in his citrus orchard; to Mr V. CIULLA and Mr S. CANDELA, who helped in sampling and in preparing mite slides.

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