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Survey of natural enemies of spider mites (Acari: Tetranychidae) in citrus orchards in eastern Spain

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Abstract

Field surveys were conducted from 2004 to 2007 to determine the species composition and relative abundance of natural enemies associated with colonies of either the citrus red mite, *Panonychus citri*, or the two spotted spider mite, *Tetranychus urticae*, in Valencian citrus orchards (eastern Spain). Fourteen species were recorded, six phytoseiid mites and eight insect predators. Two of them are reported for the first time on citrus in Spain and two more are first reports as predators associated with *T. urticae*. The community of predators associated with *T. urticae* and *P. citri* was almost identical, and the Morisita-Horn index of similarity between both natural enemy complexes was close to one, suggesting that predators forage on both pest species. Quantifying the presence of many known spider mites predators in Valencian citrus orchards is an important first step towards spider-mite control. A challenge for future studies will be to establish conservation and/or augmentation management strategies for these predators, especially to improve *T. urticae* biological control.

Key words: Phytoseiidae, *Tetranychus urticae*, *Panonychus citri*, predators, biological control

Introduction

The citrus red mite, *Panonychus citri* (McGregor) (Acari: Tetranychidae), and the two spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), are the most damaging tetranychid mites affecting citrus orchards in Spain. Feeding activity by *P. citri*, a spider mite that produces little webbing, causes silvering on both leaves and fruits. Severe infestations by this species can cause defoliation followed by twig dieback. When these symptoms occur near to fruit colour change, the silvering persists, leading to the downgrade of fruit (García-Marí and Del Rivero 1981). *Panonychus citri* is particularly abundant on sweet orange trees [*Citrus sinensis* (L.) Osbeck] at the end of the summer, between August and October (Ferragut et al. 1988).

Tetranychus urticae is mainly found on clementine (*Citrus reticulata* Blanco) and lemon trees (*Citrus lemon* Burm. f.). Its populations are active all year (Martínez-Ferrer et al. 2006). It inhabits the lower side of leaves and covers its colonies with dense webbing. The damage caused by this species is characterized by yellowish chlorotic spots that can be visible on the upper side of leaves. Heavy *T. urticae* infestations combined with water stress can cause a sudden massive leaf drop (Aucejo-Romero et al. 2004). At the end of summer, *T. urticae* causes characteristic fruit scarring and downgrades fruit (Ansaloni et al. 2008; Aucejo-Romero et al. 2004; Martínez-Ferrer et al. 2006).

The populations of *P. citri* are usually controlled by indigenous predators, mainly by the phytoseiid mite *Euseius stipulatus* (Athias-Henriot) (Acari: Phytoseiidae) (Ferragut et al. 1988; Ferragut et al. 1992; García-Marí et al. 1983; García-Marí et al. 1986). That is the reason why conservation of this phytoseiid species is a key factor for the IPM success in citrus orchards (Ferragut et al. 1988; Urbaneja et al. 2008). Nevertheless, other predatory species have also been frequently found associated with *P. citri* in Spain, such as the insects *Stethorus punctillum* Weise (Coleoptera: Coccinellidae), *Contwenzia psociformis* Curt (Neuroptera: Coniopterygidae) and *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae), and the predatory mites *Typhlodromus phialatus* Athias-Henriot, *Neoseiulus californicus* (McGregor) (Acari: Phytoseiidae) and *Agistemus* sp. (Acari: Stigmaeidae) (García-Marí et al. 1983; García-Marí and Del Rivero 1981; Ripollés et al. 1995).

In contrast, the natural control of *T. urticae* is far from being satisfactory and this species is still a major pest of clementine mandarines (Ansaloni et al. 2008; Aucejo 2005; Aucejo-Romero et al. 2004; Martínez-Ferrer et al. 2006) despite the presence of several predatory species found in association with this pest's webbing: *S. punctillum, C. psociformis, T. phialatus* and *N. californicus* (García-Marí et al. 1991; Ripollés et al. 1995; Ripollés and Meliá 1980). Because of the economic damage caused by *T. urticae* on clementines, the extensive use of acaricides by growers has become a common practice. However, chemical control decimates beneficials, induces uncontrolled proliferations of *T. urticae* and other pests, accelerates the formation of pesticide resistant spider mite strains, and generates problems associated with pesticide residue on fruit (Ansaloni et al. 2008; Aucejo 2005). In recent years, however, much emphasis has been placed on implementing environmentally safe measures to the management of *T. urticae*, such as biological control.

A necessary step, previous to implementation of biological control measures against *T. urticae* in citrus orchards, is the determination of the natural enemy species composition that co-occur with this pest. In most of the abovementioned references, citations of the presence of natural enemies were obtained as part of single observations [except for the studies on citrus red-mite control by the predatory mite *E. stipulatus* (Ferragut et al. 1988; Ferragut et al. 1992; García-Marí et al. 1983; García-Marí et al. 1986)]. At present there is no available research on the relative importance of natural enemies on both the citrus red and the two spotted spider mites. Therefore, this work aimed at cataloguing the natural enemies associated with *T. urticae* colonies in Valencian citrus orchards and at evaluating their relative abundance. At the same time we also inventoried the natural enemies associated with *P. citri* given that acquiring knowledge on the spider-mite's natural enemy complex on citrus may be useful when designing measures against other invasive tetranychid pests in the Valencian region. Indeed, two new tetranychid species have been introduced into Spain recently, *Eutetranychus orientalis* (Klein) and *Eutetranychus banksi* (McGregor) (García et al. 2003).

Material and methods

Sampling sites

A total of 168 samples were taken from 147 orchards located throughout the Valencian region (Comunidad Valenciana) from March to December, along a four–year period (2004-2007) (Figure 1). One hundred and five samples were taken from *T. urticae* naturally infested clementine orchards and 63 were taken from *P. citri* naturally infested sweet orange orchards.

Natural enemies on symptomatic leaves with presence of spider mite females

To find out which natural enemies were present on spider mite colonies, 50 symptomatic leaves from the outer part of the tree canopy with presence of either *T. urticae* or *P. citri* females, were collected at each sampling site. These leaves were chosen as both pests are found in higher densities here (García-Marí et al. 1983; Martínez-Ferrer et al. 2006). As a rule, no more than four leaves were taken per tree. Leaves were individually placed inside zip plastic bags and transported to the laboratory inside a portable cooling box. In the laboratory, a stereomicroscope was used to quantify, the spider-mite infestation level of these leaves on an index ranging from 1 to 3. Leaves were assigned the lowest value (1) when only one female spider mite was present, the intermediate value (2) when 2 to 5 females were counted and the highest value (3) when they harboured more than 5 females. For each sampled orchard, the number of each category of leaves was counted and multiplied by 1, 3 or 6, respectively. The addition of all 3 figures was considered as the mean leaf spider-mite infestation level of each orchard. The numbers of phytoseiid mites and insect predators were also recorded; a stereomicroscope was used to inspect the leaves and bags. Adult phytoseiid mites were collected and mounted on microscope slides with Hoyer's medium after clearing in lactic acid. Then, they were identified to species using a phase contrast microscope. While immature phytoseiids were not taken into account for species level estimations, immature and adult insects were all identified to species. Unidentifiable young insect predators were allowed to develop prior to species identification.

Taken into account all surveys, the total number of individuals of each group of predators (insects and phytoseiids) and of each species was calculated per symptomatic leaf with presence of either *P. citri* or *T.urticae* females. Likewise, the frequencies of appearance in orchards and the relative abundance of each species within each of the two groups of predators were determined. The frequency of appearance of a certain species in the orchards sampled was calculated dividing the number of orchards where this species was found by the total number of orchards sampled.

Then, data were organized in three periods that corresponded to the local seasons: a) a period with mild temperatures and medium relative humidity (RH) (from March to June); b) a period with high temperatures and low RH (July and August); and c) a second period with mild temperatures and medium RH (from September to December). The absolute abundance of each species per symptomatic leaf with spider mite presence was calculated again for each season. The number of sampling sites visited during each period for *T. urticae* and *P. citri* infested orchards, respectively, was 31 and 15 in the first period, 26 and 13 in the second, and 48 and 35 in the third period. Despite the efforts, not enough numbers of natural spider mite infested orchards were found during January and February to be included in the work.

Phytoseiids on randomly collected leaves

In order to compare the phytoseiid-mite distribution on symptomatic leaves with presence of spider mite females with that on randomly taken leaves, a complementary sampling method was carried out for phytoseiids during the last 2 years (2006 and 2007). In 60 orchards infested with *T. urticae* and in 48 infested with *P. citri,* 100 randomly taken leaves were collected. As above, no more than four leaves were taken per tree. Leaves were, therefore, either symptomatic or not and either from the periphery or from inside the canopy of each tree. All leaves from the same sampling site were placed inside the same zip plastic bag and transported to the laboratory as above. There, predatory mites were extracted using Berlese funnels and mounted on microscope slides for species identification. Immature phytoseiids were not taken into account for the species level calculations. The absolute abundance per leaf of the total predatory mites and the relative abundance of each species was calculated.

Data analysis

The mean numbers of insects and mites as well as the mean number of individuals of each phytoseiid and insect species per symptomatic leaf with presence of spider mite females, were compared between leaves that had either *P. citri* or *T. urticae* females with *T*-tests. Data between seasons were subjected to a one-way analysis of variance. When the assumptions of normality and homogeneity of variance could not be fulfilled, a Kruskal-Wallis test joined with a Mann-Whitney *U*-test for pairwise comparisons was applied. SPSS 15.0 software was used for statistic analysis.

The level of similarity between the two natural enemy complexes, i.e. that associated with *P. citri* and that to *T. urticae*, was determined by the Morisita-Horn's index of similarity (Krebs 1999). The Morisita-Horn index varies from 0 (no similarity) to about 1.0 (complete similarity). The software EstimateS was used to calculate this index (Colwell 2006).

Results

Natural enemies on symptomatic leaves with presence of spider mite females

There was no significant difference between the mean leaf infestation level of symptomatic leaves with presence of spider mite females in the *T. urticae* infested orchards (2.7 ± 0.2) and *P. citri* infested orchards (2.7 ± 0.1) (*T*=0.023; *df*= 50.083*P*=0.981).

Only two species, *Amblyseiella setosa* Muma and *Proprioseiopsis bordjelaini* (Athias-Henriot) (Acari: Phytoseiidae), were found exclusively on *T. urticae* infested leaves, yet at very low numbers (one and two individuals, respectively) (Table 1). The community of phytoseiids found on leaves with presence of either the citrus red mite or the two spotted spider mite was very similar, with a Morisita-Horn similarity index of 0.865. It was mainly composed of *E. stipulatus*, *T. phialatus*, *N. californicus* and *Phytoseiulus persimilis* Athias-Henriot.

The mean (± S.E.) of the total phytoseiid mites per leaf was not statistically different between both spider mites colonies (Table 1). The abundance of *E. stipulatus* was not statistically different between colonies. *Euseius stipulatus* was the dominant species on both types of colonies; this was ca. 81% and 69% of the total number of phytoseiids found on *P. citri* and *T. urticae* infested leaves, respectively. Together with *T. phialatus*, *E. stipulatus* represented c.a. 96% of the Phytoseiidae found on symptomatic leaves with presence of the citrus red mite (Table 1). Higher numbers of *P. persimilis* and *N. californicus* were found on *T. urticae* infested leaves whereas the abundance of *T. phialatus* was higher on leaves with *P. citri* (Table 1). The order of magnitude of the main four species of phytoseiids on each spider mite was the same for abundance and for frequency of appearance in orchards (Figure 2). No significant differences were observed between seasons for any of the four most abundant phytoseiids found associated with either spider mite (Table 2).

Eight insect predator species were found in association with both *T. urticae* and *P. citri* (Table 3). The Morisita-Horn similarity index of the community of insect predators was even closer to complete similarity: 0.946. The mean (± S.E.) total number of insect natural enemies per symptomatic leaf with presence of *T. urticae* females was significantly higher than that leaves with presence of *P. citri* females (Table 3). These values were approximately 2.5 times lower than the number of phytoseiids per leaf. The coccinelid *S. punctillum* was the most abundant insect predator on both spider mite colonies. The predators *C. carnea* and *Feltiella acarisuga* (Vallot) (Diptera: Cecidomyidae) were statistically more abundant on *T. urticae* than on *P. citri* colonies. The abundance of the other species was similar between colonies (Table 3). The order of magnitude of the insect-predator species on each spider mite was not the same for abundance than for frequency of appearance in orchards (Figure 3).

Except for *C. psociformis* which was more abundant on March-June than in the other two periods considered, the abundance of the rest of predatory insects was not significantly different between seasons on either spider mite (Table 2).

The comparison of both natural enemy groups together on symptomatic leaves with presence of *P. citri* and *T. urticae* gave a Morisita-Horn similarity index of 0.879.

Phytoseiids on randomly taken leaves

Because the number of identified phytoseiid mites was not as high as using the previous methodology, data of phytoseiid abundance on randomly taken leaves were only plotted as percentages of relative abundance (Figure 4). The number of phytoseiids per random leaf on *T. urticae* naturally infested trees was approximately the same as for *P. citri* (≈ 0.1 individuals/leaf). These values were well below those estimated when the sampling method consisted on collecting leaves with spider mite female presence (≈ 0.45-0.33 phytoseiids/leaf respectively). The four most abundant species of phytoseiids detected with the previous sampling method were also found on randomly taken leaves, and their relative abundance followed similar patterns as on symptomatic leaves with presence of spider mites females for both spider mite species (Figure 4).

The comparison of the two phytoseiid complexes, the one associated with *P. citri* and the one associated with *T. urticae*, found on these kind of leaves gave a Morisita-Horn similarity index of 0.939.

Discussion

The communities of natural enemies collected in orchards naturally infested by *P. citri* or *T. urticae* were almost identical even though abundances and frequencies of appearance in orchards of each species separately were slightly different. The Morisita-Horn indexes of similarity were close to 1 for both predatory insects and mites, thereby suggesting that the spider mite's natural enemies inhabiting citrus trees forage on both spider mite species.

The gall midge *F. acarisuga* and the thrips *Scolothrips longicornis* Priesner (Thysanoptera: Thripidae) had not been reported on citrus in Spain previously. These two species are frequent and play an important role in controlling spider mite populations in other crop systems in Spain (Calvo et al. 2003; García-Marí and González-Zamora 1999; Lacasa and Llorens 1996; Lacasa and Llorens 1998).

The neuropteran *Semidalis aleyrodiformis* Stephens (Neuroptera: Coniopterygidae), which has recently been identified as one of the most abundant neuropteran coniopterygids on citrus in the Valencian region (Alvis 2003), had not been reported previously as associated with spider-mite colonies in the field. Under laboratory conditions, this species is able to complete development when fed exclusively either on *T. urticae* or on *P. citri* (Agekyan 1979; León and García-Marí 2005), and therefore, it may be playing a part in the natural control of spider mites in citrus. Likewise, the thread-legged bug *Empicoris rubromaculatus* (Blackburn) (Hemiptera: Reduviidae) had also been reported in clementine orchards in Tarragona (Northeast of Spain) as a part of a hemipteran survey in citrus (Ribes et al. 2004). We observed this species feeding on *T. urticae*. However, there are few predation studies of this species on spider mites and its abundance in the field is low, therefore further research is needed to discover whether this species could play a role in spider-mite control. Similarly, the phytoseiid *P. persimilis,* the most important natural enemy of *T. urticae,* although reported on citrus in Spain, was considered to be rare (García-Marí et al. 1986) and, therefore, its expected role as a possible biocontrol agent of *T. urticae* on citrus to be minimal. Our results suggest that its relative importance is higher than previously thought and may be as high as it is in other citrus-growing areas (Smith et al. 1997).

The total number of insect predators was higher on *T. urticae* than on *P. citri* colonies. Since the spider-mite infestation level of symptomatic infested leaves with presence of *T. urticae* or *P. citri* was not significantly different, a different factor, such as the *T. urticae* more aggregative distribution when compared to that of *P. citri* could explain this pattern. Indeed, aggregation of predators in patches with prey is a common phenomenon (Sabelis 1992). Furthermore, arthropod-produced structures like spider mite webbing have been shown to affect predator survival and fitness in ways other than serving as a feeding site (Grostal and Odowd 1994; Lucas and Brodeur 1999; Roda et al. 2000; Roda et al. 2001). Prey specificity is another factor that could explain why certain species such as *N. californicus*, *P. persimilis* and *F. acarisuga* were more abundant on *T. urticae* colonies while *T. phialatus* was more abundant on *P. citri* colonies. *Neoseiulus californicus* and *P. persimilis* are considered specialists of tetranychids with medium-high webbing production (McMurtry and Croft 1997), and *F. acarisuga* is commonly associated with *Tetranychus* spp. (Chazeau 1985). In contrast, *T. phialatus* foraging is known to be hindered by the abundant webbing produced by *T. urticae* (Abad-Moyano et al unpublished work), although under laboratory conditions on arenas with low amount of webbing, *T. urticae* was considered a food source as adequate as *P. citri* for this species (Ferragut et al. 1987). Higher levels of the generalist *C. carnea* on *T. urticae* colonies could be related to its association to aphids, which are more frequent on clementines than on sweet orange trees (Hermoso de Mendoza et al. 1986). The higher abundance of *C. psociformis* in March-June on *P. citri* infested orchards compared to the other 2 seasons may be related to increase of availability of alternative preys. A positive correlation was already observed between this predator and scales in citrus (Alvis 2003).

Panonychus citri is considered a good food source for *E. stipulatus* (Ferragut et al. 1987), however this phytoseiid cannot complete its life-cycle when fed exclusively *T. urticae* (Abad-Moyano et al unpublished work; Ferragut et al. 1987). The prevailing dominance of *E. stipulatus* in infested leaves of both spider mites could be explained by its broad diet range. *Euseius stipulatus* is a specialised pollen feeder species (McMurtry and Croft 1997) that can fed on many different prey types (García-Marí et al. 1991) and, additionally, it is suspected to suck up plant liquids and, possibly, nutrients from the host plant as other *Euseius* species do (Grafton-Cardwell and Ouyang 1996; McMurtry 1992; Nomikou 2003; Schausberger 1997). Higher intraguild predation ability than co-occurring phytoseiid species could also be one of the factors contributing to the *E. stipulatus* dominance in citrus. Indeed, diverse authors have pointed out competition as the main reason for the dominance of one specific phytoseiid species in a particular phytoseiid complex (Schausberger 1997).

Stethorus punctillum, which was found to be the most abundant coccinellid in citrus orchards in Valencia (Alvis 2003), is well known as a predator of tetranychid mites (Roy et al. 2003). This explains its high abundance and frequency in both *P. citri* and *T. urticae* colonies. Several species of *Stethorus* have been reported as potential biological control agents of spider mites in agricultural systems (Hull et al. 1977; Rott and Ponsonby 2000; Roy et al. 2005; Yang et al. 1996). However, because of the low rate of natural increase of *S. punctillum* relative to that of its tetranychid prey (Roy et al. 2003), the effectiveness of this predator as a biocontrol agent of spider mites is thought not be based on its numerical response but rather on its ability to locate prey patches and its dispersal ability (Congdon et al. 1993).

Predatory mites other than phytoseiid mites were not found in this survey. However García-Marí et al. (1983) mentioned the Stigmaeidae *Zetzellia* sp. and *Agystemus cyprius* (González) and the Bdellidae *Bdellodes longirrostris* (Hermann) as predators of *P. citri*. in Spanish citrus orchards.

The data presented in this work show that many of the species known to be predators of spider mites in our geographical area are present in citrus leaves infested by either *T. urticae* or *P. citri.* The natural enemies found in our surveys belong to many different groups of arthropod predators, i.e. Acari, Coleoptera, Diptera, Hemiptera, Thysanoptera and Neuroptera. Some of the species found are generalists, such as *C. carnea* and other are specialists, such as *P. persimilis* and *F. acarisuga*. Generalists and specialists are complementary and can together reduce the spatial, temporal and developmental refuges of a phytophagous mite. This is an encouraging scenario for future research on biological control strategies against spider mites on citrus, especially for *T. urticae* which is still an unresolved problem. However, first it is necessary to discover the role performed by each predator found in the survey in the control of these spider-mite species.. A challenge for future studies will be to establish the adequate conservation and/or augmentation management strategies, at least for those natural enemies with higher biocontrol effects, to enhance *T. urticae* biological control. Preliminary augmentative releases of *P. persimilis* and *N. californicus* proved successful in controlling *T. urticae* under citrus nursery conditions (Abad-Moyano et al unpublished work).

Furthermore, two recently introduced spider mite species in Spain, *E. orientalis* and *E. banksi*, colonize leaves in a similar manner to that of the citrus red mite, and they also produce little webbing. Therefore, it is expected that those predators attacking *P. citri* will also forage on *Eutetranychus* species (McMurtry

1985). Indeed, *Euseius* sp., *Typhlodromus* sp. and *Stethorus* sp. have been reported as predators of *Eutetranychus* species in citrus of other parts of the world (Momen and El-Borolossy 1997; Smith et al. 1997; Swirski et al. 1967; Swirski et al. 1970).

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Table 1 Average numbers of phytoseiids per symptomatic leaf (mean ± SE) with presence of *T. urticae* or *P. citri* , their relative abundance (in parenthesis; %) and *T*-test results of the pairwise comparisons ($P < 0.05$). n= total number of phytoseiids collected

	on ***T. urticae***	on ***P. citri***	*T*-test (***T*; *df*; *P***)
Euseius stipulatus Athias-Henriot	0.166 ± 0.019 (68.6)	0.146 ± 0.013 (80.8)	0.769; 134,810; 0.443
Phytoseiulus persimilis Athias-Henriot	0.035 ± 0.007 (14.5)	0.0002 ± 0.000 (0.1)	4.844; 78,007; < 0.001
Neoseiulus californicus (McGregor)	0.028 ± 0.007 (11.5)	0.008 ± 0.005 (4.2)	2.499; 127,282; 0.014
Typhlodromus phialatus Athias-Henriot	0.012 ± 0.002 (5.1)	0.027 ± 0.003 (14.9)	-3.485; 109.654; 0.001
Proprioseiopsis bordjelaini (Athias-Henriot)	0.0005 ± 0.0003 (0.2)	0.0 ± 0.0 (0)	*
Amblyseiella setosa Muma	0.0003 ± 0.0003 (0.1)	0.0 ± 0.0 (0)	*
Not-identified	0.291 ± 0.144 n=1,768	0.166 ± 0.023 n=696	-
Total	**0.449 ± 0.053** **n=2,617**	**0.325 ± 0.027** **n=1,267**	**1.880; 135; 0.062**

* Statistical analysis were not conducted because numbers collected were insufficient

Table 2 ANOVA (*df*; *F-value*; *P-value*)^{a}, Kruskal-Wallis test (χ^{2}; *df*; *P*)^{b} or Mann-Whitney *U*-test (*Z-value*; *P-value*)^{c} results for the comparison of the abundance of each predator species and of the spider-mite infestation levels on symptomatic leaves with presence of *P. citri* or *T. urticae* between seasons ($P < 0.05$).

	on ***T. urticae***	on ***P. citri***
Euseius stipulatus Athias-Henriot	2; 0.040; 0.960 ^{a}	2; 1.300; 0.281^{a}
Phytoseiulus persimilis Athias-Henriot	2; 1.221; 0.301^{a}	*
Neoseiulus californicus (McGregor)	2; 0.686; 0.507^{a}	2; 0.546; 0.582^{a}
Typhlodromus phialatus Athias-Henriot	2; 1.337; 0.269^{a}	1.472; 2; 0.479 ^{b}
Stethorus punctillum Weise	2; 2.078; 0.130^{a}	2; 1.118; 0.334^{a}
Chrysoperla carnea Stephens	4.634; 2; 0.099^{b}	2; 1.946; 0.152^{a}
Feltiella acarisuga (Vallot)	2; 0.019; 0.981^{a}	2; 0.914; 0.406^{a}
Scolothrips longicornis Priesner	2; 0.455; 0.635^{a}	0.738; 2;0.691 ^{b}
Contwenzia psociformis Curt	2; 0.646; 0.526^{a}	11.024; 2; 0.004^{b} Pair Spring-Summer: -3.328; 0.001^{c} Pair Spring-Autumn: -2.810; 0.005^{c} Pair Autumn-Summer: -0.150; 0.880^{c}
Spider-mite infestation level	2; 0.170; 0.844^{a}	2; 3.115; 0.058^{a}

* Statistical analysis were not conducted because numbers collected were insufficient

Table 3 Average numbers of insect predators per symptomatic leaf (mean ± SE) with presence of *T. urticae* or *P. citri*, their relative abundance (in parenthesis; %) and *T*-test results of the pairwise comparisons. n= total number of insect predators collected ($P < 0.05$).

	on ***T. urticae***	on ***P. citri***	*T*-test (***T*; *df*; *P***)
Stethorus punctillum Weise	0.087 ± 0.008 (48.2)	0.089 ± 0.019 (66.1)	-0.092; 166; 0.927
Chrysoperla carnea Stephens	0.043 ± 0.007 (23.8)	0.015 ± 0.002 (10.9)	4.184; 123.482; < 0.001
Feltiella acarisuga (Vallot)	0.014 ± 0.002 (7.6)	0.003 ± 0.000 (2.0)	6.327; 145.086; < 0.001
Scolothrips longicornis Priesner	0.012 ±0.001 (6.5)	0.011 ± 0.002 (8.2)	0.333; 139.853; 0.739
Contwenzia psociformis Curt	0.011 ± 0.002 (6.2)	0.015 ± 0.005 (11.3)	-0.815; 166; 0.416
Semidalis aleyrodiformis Stephens	0.007 ± 0.001 (3.7)	0.001 ± 0.000 (0.9)	*
Empicoris rubromaculatus (Blackburn)	0.006 ± 0.003 (3.5)	0.0002 ± 0.00 (0.1)	*
Anthocoridae spp.	0.0009 ± 0.0007 (0.5)	0.0006 ± 0.0004 (0.5)	*
Total	**0.181 ± 0.013** **n= 1,022**	**0.135 ± 0.021** **n= 467**	**2.013; 166; 0.046**

* Statistical analysis were not conducted because numbers collected were insufficient

Fig. 1 Location of sampling sites in the Valencian region (Comunidad Valenciana, Spain). (Legend: Diamonds correspond to sites sampled for *P. citri*, and filled circles to sites sampled for *T. urticae*.)

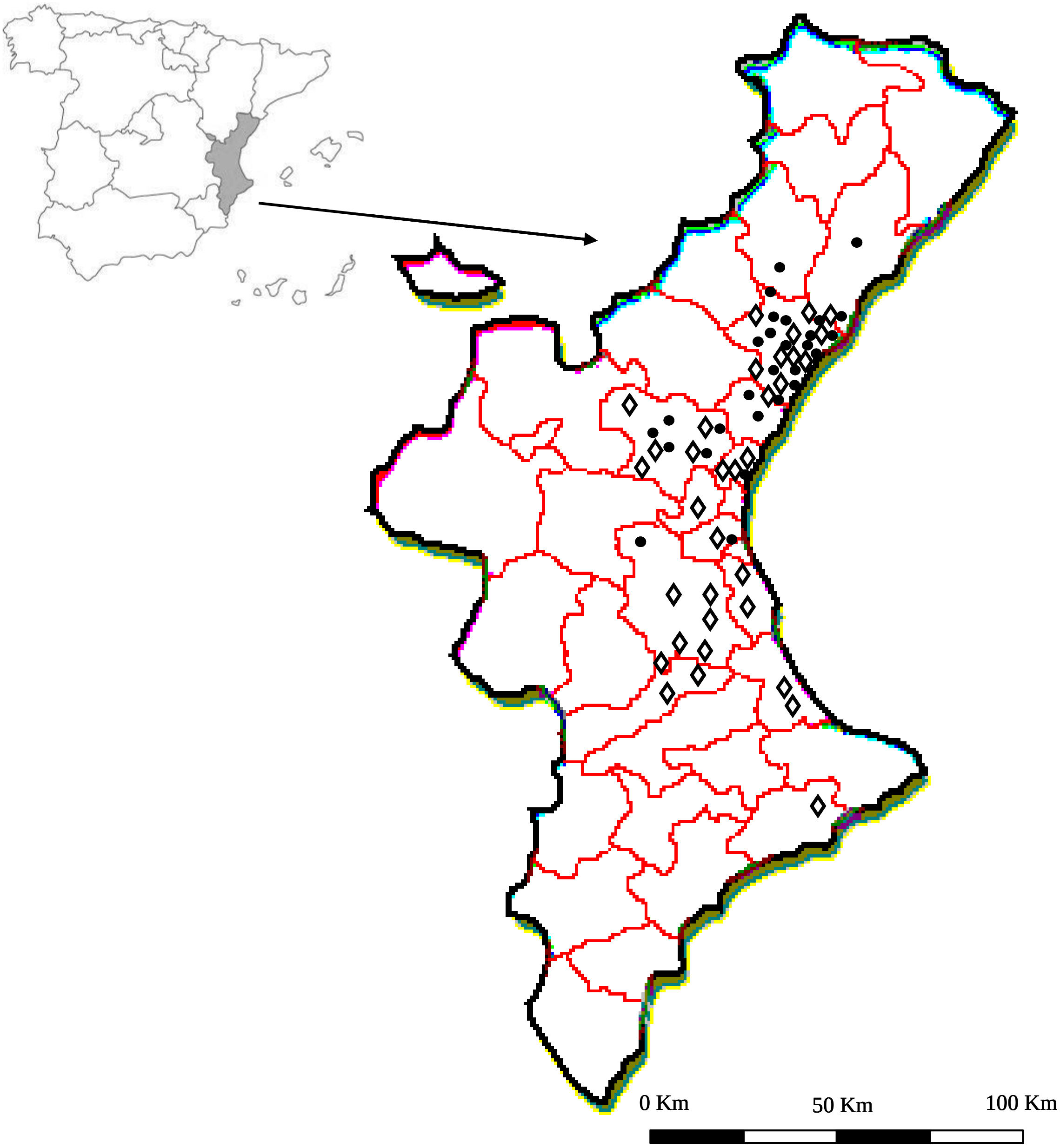


Fig. 2 Frequency of appearance in the orchards sampled (%) of the most abundant phytoseiid species found on (a) *T. urticae* and (b) *P. citri* colonies. n= 147 and 63 orchards for *T. urticae* and *P. citri*, respectively

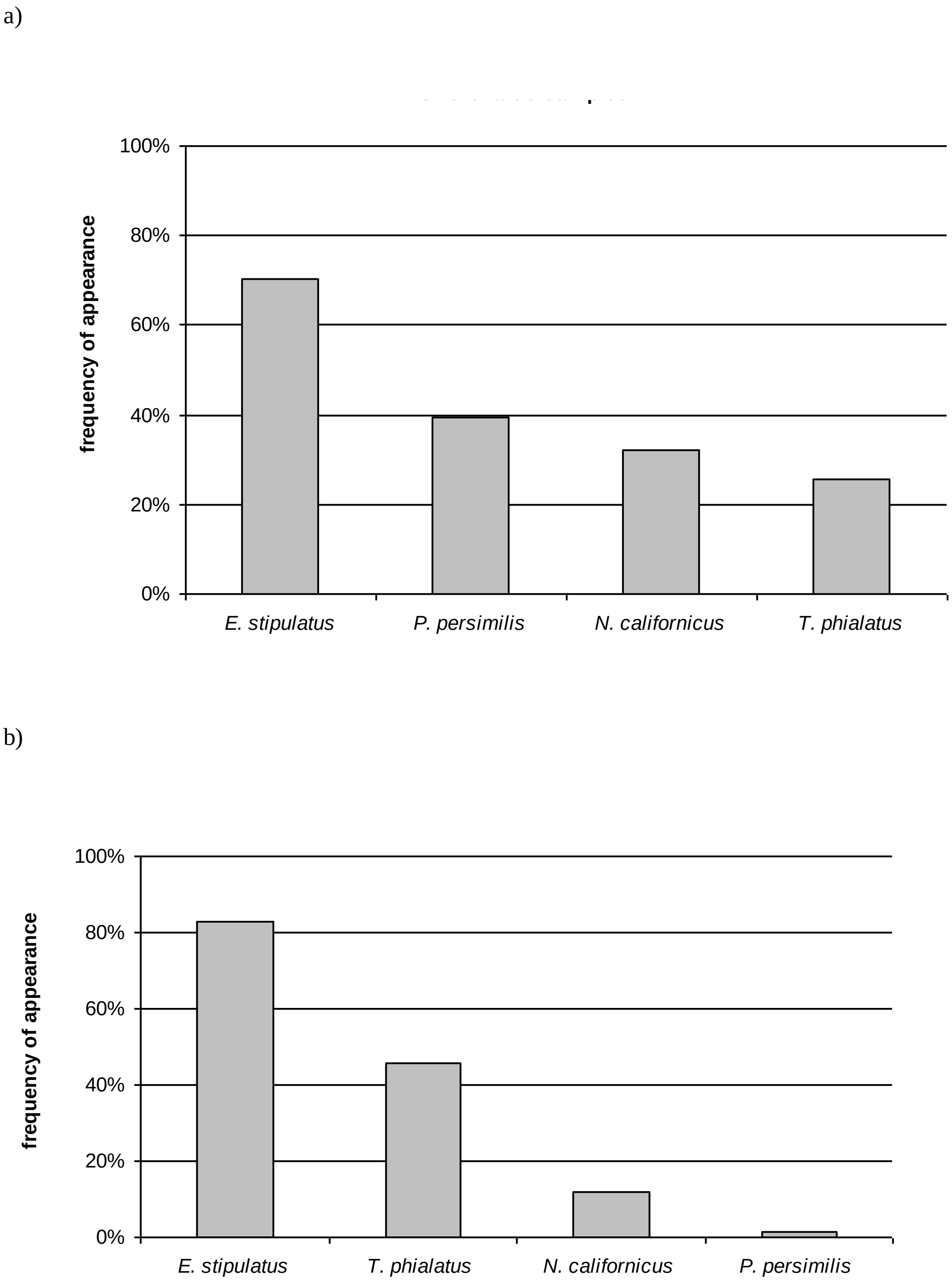
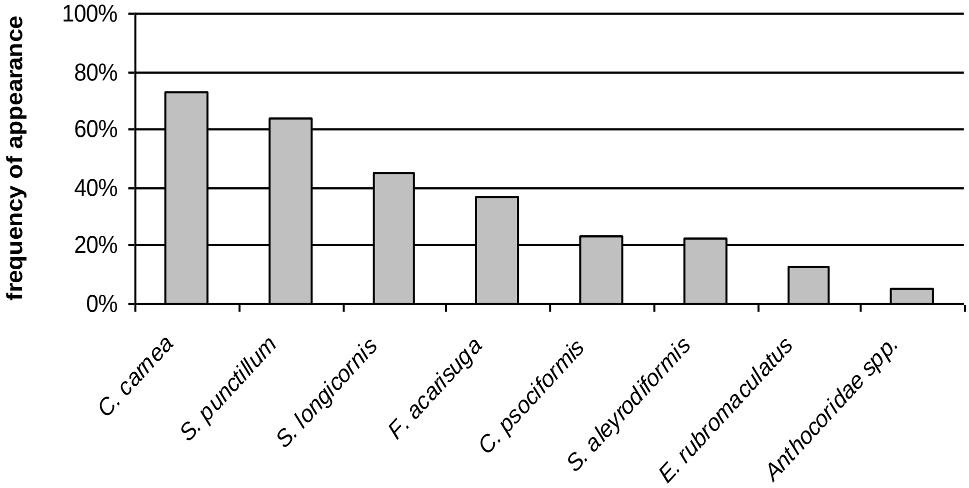


Fig. 3 Frequency of appearance in the orchards sampled (%) of the most abundant insect predator species found on (a) *T. urticae* and (b) *P. citri* colonies. n= 147 and 63 orchards for *T. urticae* and *P. citri*, respectively

a)



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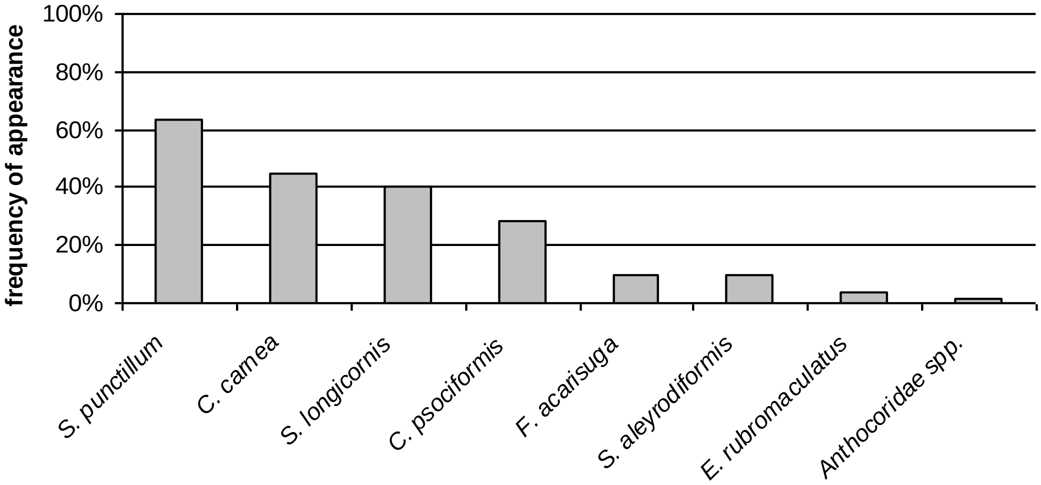
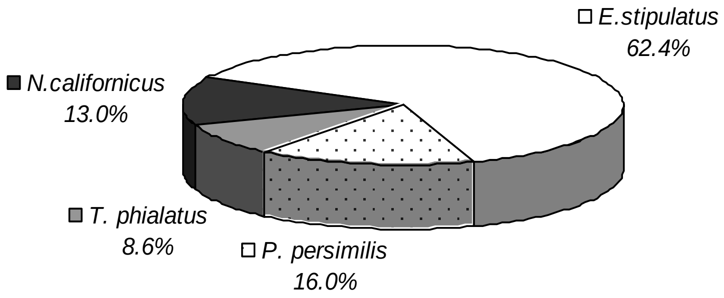


Fig. 4 Relative abundance of phytoseiid species collected on leaves randomly taken from trees infested by (a) *T. urticae* or (b) *P. citri*. n= 545 and 364 predatory mites for *T. urticae* and *P. citri*, respectively

a)



b)