CROP PROTECTION

Faunistic Analysis of Sharpshooters (Hemiptera: Auchenorrhyncha, Cicadellidae) in a 'Westin' Sweet Orange Orchard

Juliana H.C. Coelho, Nivian L. Ximenes, Marcos R. Felippe, Luiz H. Montesino, Luiz F. Garbim, André L. Sanches, Wolney Dalla Pria Jr. and Pedro T. Yamamoto

FUNDECITRUS - Av. Dr. Adhemar Pereira de Barros, 201, Vila Melhado, C. postal 391, 14801-970, Araraquara, SP

Análise Faunística de Cicadelíneos (Hemiptera: Auchenorrhyncha, Cicadellidae) em Pomar de Laranjeira 'Westin'

RESUMO - O objetivo deste trabalho foi analisar a fauna de cigarrinhas em pomar de laranjeira 'Westin' enxertada sobre limoeiro 'Cravo', em plantas com cinco anos de idade. Foram instaladas armadilhas adesivas amarelas na borda da mata, na periferia do talhão e no interior do talhão, sendo avaliadas quinzenalmente, por três anos. As cigarrinhas que ocorreram com maior freqüência foram *Acrogonia citrina* Marucci & Cavichioli, *Bucephalogonia xanthophis* (Berg) e *Oncometopia facialis* (Signoret). *B. xanthophis* ocorreu mais na borda da mata, principalmente na primavera e inverno. *A. citrina* ocorreu mais na borda da mata, principalmente na primavera. A a maior incidência de *O. facialis* foi no interior do talhão, e maior na primavera e verão. A ocorrência de outros cicadelíneos foi maior na borda da mata, principalmente no verão. Segundo a análise faunística, *A. citrina, B. xanthophis, Dilobopterus costalimai* Young e *O. facialis* foram predominantes em todos os locais estudados; *A. citrina*, *B. xanthophis* e *O. facialis* foram super dominantes, super abundantes, super freqüentes e constantes, exceto no interior do talhão, onde *B. xanthophis* foi dominante, muito abundante, muito freqüente e constante. *D. costalimai* e *Homalodisca ignorata* Melichar foram dominantes, muito abundantes e muito freqüentes na borda da mata e periferia do talhão, sendo que *D. costalimai* também foi predominante no interior do talhão. *Scopogonalia subolivacea* (Stål) foi predominante na borda da mata e interior do talhão e *Plesiommata corniculata* Young, na periferia do talhão (ambas foram dominantes, muito abundantes, muito freqüentes e acessórias).

PALAVRAS-CHAVE: Cicadellinae, *Citrus sinensis*, Clorose Variegada dos Citros, ecologia

ABSTRACT - The purpose of this study was to analyze sharpshooter fauna in a five-year-old 'Westin' sweet orange orchard. Yellow sticky traps were placed on the edge of a forest, and on the periphery and inside the citrus stand. The traps were evaluated fortnightly, for three years. The most frequent species were *Acrogonia citrina* Marucci & Cavichioli, *Bucephalogonia xanthophis* (Berg), and *Oncometopia facialis* (Signoret). *B. xanthophis* occurred more in the forest edge, especially on spring and winter. *A. citrina* occurred most frequently in the forest edge, especially on spring. The highest incidence of *O. facialis* was inside the citrus stand, on spring and summer. Other cicadellids occurred more often in the forest edge, especially on summer. *A. citrina, B. xanthophis, Dilobopterus costalimai* Young, and *O. facialis* were predominant in all places studied. *A. citrina, B. xanthophis* and *O. facialis* were super dominant, super abundant, super frequent, and constant, except inside the stand, where *B. xanthophis* was dominant, very abundant, very frequent, and constant. *D. costalimai* and *Homalodisca ignorata* Melichar were dominant, very abundant, and very frequent in the forest edge and in the periphery of the stand, and *D. costalimai* was also predominant inside the stand. *Scopogonalia subolivacea* (Stål) was predominant in the forest edge and inside the stand, while *Plesiommata corniculata* Young was predominant in the periphery (both were dominant, very abundant, very frequent, and accessory).

KEY WORDS: Cicadellinae, *Citrus sinensis*, Citrus Variegated Chlorosis, ecology

The growth of citriculture and increased citrus productivity are affected by several diseases. Among them, the Citrus Variegated Chlorosis (CVC) became one of the most serious problems since it was first discovered towards the end of the 1980's. CVC was first reported in orchards from Colina, SP, and later in the Triângulo Mineiro region, MG, and in the North and Northwest regions of São Paulo state (Rossetti & de Negri 1990).

The disease affects all commercial sweet orange varieties on the various rootstocks used in citrus. No symptoms have

been found in tangerine, tangor, lemon, and acid lime trees (Carvalho *et al*. 1994). The disease affects mainly fruit quality, reducing their size and making them unsuitable to be sold fresh and also, in part, inadequate to production of concentrated juice (Rossetti & De Negri 1990). The yield reduction in fruit weight of severely attacked plants is approximately 75% (Ayres *et al*. 2000).

CVC is caused by a gram-negative, rod-shaped bacterium, with a wrinkled cell wall, limited to the plant's xylem vessels, named *Xylella fastidiosa* Wells *et al*. (Lee *et al*. 1993). The bacterium also infects grape, peach, almond, and coffee, among other cultivated plants (Purcell 1994, Paradela Filho *et al*. 1995), and is transmitted by sharpshooters of the Cicadellidae family (sub-family Cicadellinae), which necessarily feed on xylem vessels (Purcell 1994). Transmission studies have so far identified 12 sharpshooter species that act as vectors of the bacterium in citrus (Lopes *et al*. 1996, Roberto *et al*. 1996, Yamamoto *et al*. 2002). In addition to vector insects, *X. fastidiosa* can be transmitted in citrus by grafting (Machado *et al*. 1994).

Out of the 12 sharpshooter species identified as vectors, *Acrogonia citrina* Marucci & Cavichioli, *Bucephalogonia xanthophis* (Berg), *Dilobopterus costalimai* Young, and *Oncometopia facialis* (Signoret) offer greater disease dissemination risk, since they are predominant in citrus trees (Paiva *et al*. 1996, Yamamoto & Lopes 2004). The others are of little importance as they prefer to feed on grasses or because they occur at low population densities.

Although sharpshooters occur in all seasons of the year, the greatest sharpshooter populations occur on summer and spring because of orange tree sprouting and favorable weather conditions (Yamamoto & Lopes 2004). However, in years of prolonged drought on winter extending until spring, later infestations have been observed in citrus orchards (Roberto & Yamamoto 1998).

In addition to citrus, sharpshooters can be found in several arboreal and shrubby species present in woods, forests, and swamps (Giustolin *et al*. não publicado, Yamamoto & Lopes 2004). Probably, plants in these places are used not only as feeding hosts, but also as reproductive hosts, from where adults migrate into the orchards at sprouting time, mainly corresponding to the spring and summer.

Due to the importance of vectors in the dissemination of some diseases, the identification of key species and a knowledge about their population dynamics are greatly important for integrated vector management (Yamamoto & Gravena 2000). Therefore, the establishment of effective CVC management techniques depends on knowledge about the predominant sharpshooter vector species in each ecosystem, as well as about their bioecology. The objective of this study was to investigate the sharpshooter fauna in a 'Westin' sweet orange orchard.

Material and Methods

The experiment was conducted at Nova Trento Farm, located in Gavião Peixoto, SP. The population survey was conducted in an orange orchard, variety 'Westin', grafted onto Rangpur lime, planted at a 8 × 4 m row spacing, with five-year-old plants in the beginning of the experiment. The orchard was located near a riparian forest. There was an area containing herbaceous and shrubby vegetation between the orchard and the riparian forest.

The sharpshooter population was evaluated by means of yellow sticky traps (Olson Products, Inc., Ohio, USA), measuring 7.6 × 12.7 cm. This method was selected because it measures sharpshooter abundance and activity and provides continuous collection (Purcell 1994). A total of 75 traps were installed, 25 at the edge of the forest, 25 on the periphery of the stand, near the area with herbaceous and shrubby vegetation, and 25 in the interior of the stand. The traps were evaluated every fifteen days (by quantifying the sharpshooter species stuck on both sides of the trap) and replaced monthly, for a three-year period. The traps were changed monthly, and the insects were removed in the first fortnight. The population survey started in July 1996 and continued until July 1999, except in the interior of the stand, where the survey started in August 1996.

The data on sharpshooter collections in the yellow sticky traps were submitted to statistical analysis and faunistic analysis. The predominant species, that is, those with the highest faunistic indices (Silveira Neto *et al*. 1995), were selected based on their constancy, frequency, abundance, and dominance indices. These indices were calculated using the ANAFAU software program (R.C.B. de Moraes *et al*. não publicado). In the program, discrepant data are analyzed by graphical residual analysis (Atkinson 1985) and are classified into exclusive categories known as super dominant, super abundant, and super frequent.

Constancy represents the percentage of species present in the survey. It was calculated based on the confidence interval (CI) of the arithmetic mean at 5% probability. The species were arranged into the following classes:

- Constant (w) - when the percentage of collections containing the species was above the upper CI limit;

- Accessory (y) - when the percentage of collections containing the species fell within the CI;

- Accidental (z) - when the percentage of collections containing the species was below the lower CI limit.

Frequency is the percentage of each species relative to the total number of individuals collected (Silveira Neto *et al*. 1976). Classes:

- Little frequent (lf) - when the percentage of individuals captured was below the lower CI limit;

- Frequent (f) - when the percentage of individuals captured fell within the CI;

- Very frequent (vf) - when the percentage of individuals captured was above the upper CI limit.

Abundance refers to the number of individuals per surface unit and volume unit and varies in space and time (Silveira Neto *et al*. 1976). It was determined by the total sum of individuals from each species, using a dispersion measure calculated from the CI of the arithmetic mean, at 1 and 5% probability. Classes:

- Rare (r) - number of individuals captured below the lower CI limit at 1% probability;

- Dispersed (d) - number of individuals captured between the lower CI limits at 5% and 1% probability;

- Common (c) - number of individuals captured within the CI at 5% probability;

- Abundant (a) - number of individuals captured between the upper CI limits at 5% and 1% probability;

- Very abundant (v) - number of individuals captured above the upper CI limit at 1% probability.

Dominance is the action exercised by the dominant organisms of a community. The method used by Kato *et al.*, cited by Laroca & Mielke (1975), was taken into account.

Diversity was calculated by Shannon – Wiener's Index, since it is the most commonly used index in ecology of communities (Ludwig & Reynolds 1988) and because it allows comparisons between communities.

The Equitability Index (J) represents the uniformity with which individuals are distributed in the sample. This index is obtained by the equation: J = H'/Hmax', where: H' is Shanon-Wiener's Index and Hmax' is given by the following expression: Hmax'= log s, where s is the number of species sampled.

Results and Discussion

Among the Cicadellinae, the most frequently captured species in the various sites of the 'Westin' sweet orange orchard were *B. xanthophis*, *A. citrina*, and *O. facialis* (Table 1), all proven vectors of the bacterium *X. fastidiosa* (Lopes *et al.* 1996, Roberto *et al.* 1996) and all considered key vectors for dissemination of the bacterium *X. fastidiosa* in citrus orchards (Lopes 1999).

Considering the collection sites within the property, with the exception of *O. facialis*, the other species were captured in larger numbers on the forest edge (Table 1). The greater capture of sharpshooters at that site was probably due to the occurrence of natural host plants, where they reproduce and survive during the period when no citrus shoots are available. Giustolin *et al.* (não publicado) identified 31 alternative hosts of Cicadellinae in forest areas adjacent to orange orchards, and detected the presence of nymphs and eggs in 18 plant species found in those forest areas, indicating that they are development hosts and possibly also multiplication hosts for the vectors.

As to the seasons of the year, with the exception of *B. xanthophis*, whose population was greater on spring and winter, the other species were more common on spring and summer. Yamamoto & Lopes (2004) reported that sharpshooter populations are greater on summer and spring, due to the presence of orange tree shoots and favorable weather conditions. In the same way, Coll *et al.* (1993) observed that sharpshooter populations increase in the beginning of spring, peaks on summer, and decreases in winter. Marucci *et al.* (2004) demonstrated that the presence of shoots in citrus seedlings increased the attractiveness of plants for the sharpshooters *D. costalimai* and *O. facialis*.

B. xanthophis occurred at higher numbers on the forest edge, especially in spring and winter. On the periphery of the stand, its presence was higher on spring; there were no significant differences between seasons of the year in the interior of the stand (Table 2). The fact that *B. xanthophis* is predominant on the forest edge is probably due to its preference for shrubby and herbaceous plant species (Paiva *et al.* 1996, Giustolin *et al.* não publicado), which were abundant near the riparian forest.

The species *A. citrina* occurred in higher numbers on the forest edge, followed by the stand periphery, with smaller numbers inside the stand, except on summer (Table 3). This species was more abundant on spring and summer; there was

Table 1. Occurrence of sharpshooters in different sites of a citrus-growing property and in different seasons of the year. Gavião Peixoto, SP, 1996-1999.

	B. xanthophis	*A. citrina*	*O. facialis*	Other Cicadellinae	Total
Sites					
Forest edge	0.17 a	0.54 a	0.14 b	0.12 a	0.97 a
Stand periphery	0.07 b	0.40 b	0.15 b	0.07 b	0.70 b
Stand interior	0.05 b	0.26 c	0.21 a	0.08 b	0.60 b
F test	20.30**	10.21**	4.84**	3.31*	8.02**
Seasons					
Spring	0.18 a	0.79 a	0.20 a	0.11 b	1.28 a
Summer	0.03 b	0.44 b	0.27 a	0.16 a	0.89 b
Fall	0.02 b	0.16 c	0.12 b	0.04 c	0.33 c
Winter	0.13 a	0.18 c	0.09 b	0.05 c	0.43 c
F test	29.52**	55.95**	14.59**	21.08**	58.56**
Location × season interaction	6.20**	7.18**	4.01**	1.77ns	7.21**

Means followed by the same letter, in the columns, do not differ from each other (P < 0.05).

Table 2. Occurrence of *B. xanthophis* in different sites of a citrus-growing property and in different seasons of the year. Gavião Peixoto, SP, 1996-1999.

Season	Sites			F test
	Forest edge	Stand periphery	Stand interior	
Spring	0.261 A a	0.197 AB a	0.091 B a	10.45**
Summer	0.039 A b	0.018 A b	0.022 A a	0.14ns
Fall	0.043 A b	0.009 A b	0.001 A a	0.57 ns
Winter	0.327 A a	0.060 B b	0.066 B a	26.91**
F test	24.00**	12.26**	2.43ns	

Means followed by the same upper case (rows) or lower case letter (columns) do not differ from each other (P < 0.05).

no difference on fall and winter, when this vector occurred in low numbers. *A. citrina* was captured in larger numbers on the forest edge. However, contrary to *B. xanthophis*, it prefers arboreal species (Giustolin *et al.* não publicado), and, in this case, probably the main alternative hosts consisted of arboreal species that comprised the riparian forest.

The species *O. facialis* was found more abundantly inside the stand, with larger populations on spring and summer, except on the fall (Table 4). There were no differences between seasons of the year on the forest edge, but on the stand periphery populations were larger on summer, followed by the spring, fall, and winter. Despite the fact that this species has arboreal habits and is found on a number of plants in forests adjacent to orchards, it was captured in larger numbers inside the citrus stand, except on the fall.

Most species, with the exception of *B. xanthophis*, are probably captured in the trap on the edge of the stand during migration from the forest towards the stand in the periods when orange trees are sprouting, which are preferred by the sharpshooters (Gravena *et al.* 1997). *O. facialis* is not captured in the traps on the edge of the stand due to their flight behavior, since it is a more robust and larger species, with greater flight velocity and height (Gravena 2005), therefore being able to fly higher than the traps placed near the forest edge. Blua & Morgan (2003) verified that the height differences between citrus trees and grape vines resulted in *Homalodisca coagulata* (Say) flying over the traps positioned on the interface of both crops.

When all other Cicadellinae are considered, that is, *Ciminus* sp., *D. costalimai*, *Erytrogonia sexguttata* (Fabricius), *Ferrariana trivittata* (Signoret), *Homalodisca*

ignorata Melichar, *Hortensia similis* (Walker), *Macugonalia leucomelas* (Walker), *Parathona gratiosa* (Blanchard), *Plesiommata corniculata* Young, *Sonesimia grossa* (Signoret), *Scopogonalia subolivacea* (Stal), and *Tapajosa ocellata* (Osborn), occurrence was higher on the forest edge, especially on summer (Table 5). There were no differences between seasons of the year on the periphery of the stand, whereas the occurrence of those species in the interior of the stand was higher on summer, followed by spring and fall, with lower numbers on winter. Although most of those species feed on grasses (*Ciminus* sp., *E. sexguttata*, *F. trivittata*, *H. similis*, *M. leucomelas*, *P. corniculata*, *S. grossa*, *S. subolivacea*, and *T. ocellata*), they can contribute toward *X. fastidiosa* dissemination in citrus. Purcell (1994) reported that, although the species *Draculacephala minerva* Ball and *Carneocephala fulgida* Nottingham are rare on grape vines in the Central Valley of California, USA, they contribute and are responsible for *X. fastidiosa* transmission, which causes Pierce's disease, especially in localities where grapevines are planted near reproduction sites for those species, represented by irrigated pastures, hay fields, and vegetation near irrigation canals.

Diversity and Equitability indices were higher within the citrus stand, in spite of the smaller total number of specimens and species captured, 846 and 13 respectively, followed by the forest edge with 1012 and 14 respectively, and by the periphery of the stand, with 1003 and 17, respectively (Table 6).

The species *A. citrina*, *O. facialis*, and *B. xanthophis* were predominant in all sites studied (Tables 7, 8, and 9), and are defined as super dominant, super abundant, super frequent,

Table 3. Occurrence of *A. citrina* in different sites of a citrus-growing property and in different seasons of the year. Gavião Peixoto, SP, 1996-1999.

Season	Sites			F test
	Forest edge	Stand periphery	Stand interior	
Spring	0.932 A b	0.787 B b	0.520 B b	11.41**
Summer	0.192 B a	0.548 A b	0.449 AB b	7.57**
Fall	0.236 A a	0.206 A a	0.077 A a	2.73ns
Winter	0.439 A a	0.108 B a	0.107 B a	10.06**
F test	23.72**	30.11**	18.93**	

Means followed by the same upper case (rows) or lower case letter (columns) do not differ from each other (P < 0.05).

Table 4. Occurrence of *O. facialis* in different sites of a citrus-growing property and in different seasons of the year. Gavião Peixoto, SP, 1996-1999.

Season	Sites			F test
	Forest edge	Stand periphery	Stand interior	
Spring	0.112 B a	0.157 AB ab	0.283 A b	6.93**
Summer	0.165 B a	0.267 AB b	0.366 A b	7.76**
Fall	0.167 A a	0.134 A ab	0.077 A a	1.79ns
Winter	0.089 A a	0.068 A a	0.107 A a	0.37ns
F test	1.00ns	6.63**	17.63**	

Means followed by the same upper case (rows) or lower case letter (columns) do not differ from each other (P < 0.05).

and constant. Species that fell into one of the following classes were considered predominant: very frequent, dominant, very abundant, or constant, according to Silveira Neto *et al*. (1976). These three species are the main vectors of the bacterium *X. fastidiosa* in the property. The first two species have an arboreal habit and, when present in an orchard, are found exclusively on citrus plants, rarely being found on invasive plants (Gravena *et al*. 1997). *B. xanthophis* was dominant in the stand interior, but was super dominant in the forest edge and in the periphery of the stand (Table 7).

D. costalimai was an accessory species that was observed as dominant, very abundant, and very frequent in the forest edge, the stand periphery, and the stand interior (Tables 7, 8, and 9). The same fact was observed for the species *H. ignorata*, which was dominant, very abundant, and very frequent on the forest edge and on the stand periphery (Tables 7 and 8). *D. costalimai* is one of the most common Cicadellinae species found in citrus (Roberto & Yamamoto 1997, Yamamoto & Lopes 2004). However, captures were low in the property and municipality where the survey was carried out.

B. *xanthophis* shows preference for grasses and young plants (Paiva *et al*. 1996). This is probably the reason why it was observed as super dominant, super abundant, super frequent, and constant on the forest edge and on the periphery of the stand (Tables 7 and 8), which was located near this type of vegetation. In the interior of the stand this species was dominant, very abundant, very frequent, and constant.

The species *P. corniculata* was predominant in the periphery of the stand, and was dominant, very abundant, and very frequent, possibly because of the proximity with shrubby and herbaceous species (Table 8). This sharpshooter is more easily observed on grasses, with a reduced presence in the citrus plant (Paiva *et al*. 1996, Gravena *et al*. 1997).

The species *S. subolivacea* was dominant and accessory in all sites, and was very abundant and very frequent on the forest edge (Table 7) and in the interior of the stand (Table 9), where it was considered predominant. According to Coll *et al*. (2000), this is the most abundant species in citrus throughout the year in Argentina, citrus being its most important host.

Table 5. Occurrence of other Cicadellinae in different sites of a citrus-growing property and in different seasons of the year. Gavião Peixoto, SP, 1996-1999.

Season	Sites			F test
	Forest edge	Stand periphery	Stand interior	
Spring	0.095 A a	0.085 A a	0.115 A bc	0.70ns
Summer	0.208 A b	0.117 A a	0.138 A c	5.17**
Fall	0.035 A a	0.034 A a	0.049 A ab	0.19ns
Winter	0.086 A a	0.040 A a	0.023 A a	2.30ns
F test	11.48**	4.47**	8.19**	

Means followed by the same upper case (rows) or lower case letter (columns) do not differ from each other (P < 0.05).

Table 6. Total number of individuals, numbers of species and collections, diversity, and equitability of Cicadellinae in different sites of the property. Gavião Peixoto, SP, 1996-1999.

Site	Total collected	No. of species	No. of collections	Shannon-Wiener Diversity (H')	Equitability (E)
Forest edge	1012	14	58	1.39	0.53
Stand periphery	1003	17	58	1.30	0.46
Stand interior	846	13	56	1.45	0.57

Table 7. Faunistic analysis of Cicadellinae species collected in yellow sticky traps in the period from 07/1996 to 07/1999, on the forest edge.

Species	Number of individuals	Number of collections	Dominance	Abundance	Frequency (%)	Constancy
Acrogonia citrina	561	37	SD	sa	SF (55.43)	W
Bucephalogonia xanthophis	181	35	SD	sa	SF (17.89)	W
Ciminius sp.	1	1	ND	r	LF (0.09)	Z
Dilobopterus costalimai	26	10	D	va	VF (2.57)	Y
Ferrariana trivittata	7	5	ND	c	F (0.69)	Y
Homalodisca ignorata	24	12	D	va	VF (2.37)	Y
Hortensia similis	4	3	ND	c	F (0.40)	Z
Macugonalia leucomelas	3	3	ND	d	LF (0.30)	Z
Oncometopia facialis	150	34	SD	sa	SF (14.82)	W
Parathona gratiosa	1	1	ND	r	LF (0.09)	Z
Plesiommata corniculata	14	11	D	c	F (1.38)	Y
Sonesimia grossa	2	2	ND	d	LF (0.20)	Z
Scopogonalia subolivacea	37	7	D	va	VF (3.66)	Y
Tapajosa ocellata	1	1	ND	r	LF (0.09)	Z

1 - Dominance (Sakagami and Larroca Method): ND = non-dominant; D = dominant; SD = super dominant; 2 - Abundance: r = rare; d = dispersed; c = common; va = very abundant; sa = super abundant; 3 - Frequency: LF = little frequent, F = frequent; VF = very frequent; SF = super frequent; 4 - Constancy: Z = accidental; Y = accessory; W = constant.

Table 8. Faunistic analysis of Cicadellinae species collected in yellow sticky traps in the period from 07/1996 to 07/1999 on the periphery of a 'Westin' sweet orange stand.

Species	Number of individuals	Number of collections	Dominance	Abundance	Frequency (%)	Constancy
Acrogonia citrina	588	49	SD	sa	SF (58.62)	W
Bucephalogonia xanthophis	112	24	SD	sa	SF (11.17)	W
Carneocephala sp.	1	1	ND	r	LF (0.10)	Z
Diedrocephala continua	3	3	ND	c	F (0.30)	Y
Dilobopterus costalimai	26	12	D	va	VF (2.59)	Y
Erytrogonia sexgutata	1	1	ND	r	LF (0.10)	Z
Ferrariana trivittata	5	4	ND	c	F (0.50)	Y
Homalodisca ignorata	14	3	D	va	VF (1.392)	Y
Hortensia similis	4	3	ND	c	F (0.40)	Y
Lebaja mediana	2	2	ND	d	LF (0.20)	Z
Macugonalia leucomelas	5	4	ND	c	F (0.50)	Y
Macugonalia cavifrons	1	1	ND	r	LF (0.10)	Z
Oncometopia facialis	208	43	SD	sa	SF (20.74)	W
Parathona gratiosa	1	1	ND	r	LF (0.10)	Z
Plesiommata corniculata	22	9	D	va	VF (2.19)	Y
Sonesimia grossa	1	1	ND	r	LF (0.10)	Z
Scopogonalia subolivacea	9	7	D	c	F (0.90)	Y

1 - Dominance (Sakagami and Larroca Method): ND = non-dominant; D = dominant; SD = super dominant; 2 - Abundance: r = rare; d = dispersed; c = common; va = very abundant; sa = super abundant; 3 - Frequency: LF = little frequent, F = frequent; VF = very frequent; SF = super frequent; 4 - Constancy: Z = accidental; Y = accessory; W = constant.

The other species were: non-dominant, dispersed or common, little frequent or frequent, and accidental in at least one of the collection sites (Figs. 7, 8, and 9).

Knowing the most important species for each region and the population dynamics of sharpshooters is of great importance for their management. Another important factor is

Table 9. Faunistic analysis of Cicadellinae species (Auchenorrhyncha) collected in yellow sticky traps in the period from 08/1996 to 07/1999 in the interior of a 'Westin' sweet orange stand.

Species	Number of individuals	Number of collections	Dominance	Abundance	Frequency (%)	Constancy
Acrogonia citrina	375	36	SD	sa	SF (44.33)	W
Bucephalogonia xanthophis	56	26	D	va	VF (6.62)	W
Carneocephala sp.	1	1	ND	d	LF (0.12)	Z
Dilobopterus costalimai	40	16	D	va	VF (`4.73)	Y
Ferrariana trivittata	10	8	ND	c	F (1.18)	Y
Homalodisca ignorata	5	5	ND	c	F (0.59)	Z
Hortensia similis	9	6	ND	c	F (1.06)	Y
Lebaja mediana	2	2	ND	d	LF (0.24)	Z
Macugonalia leucomelas	6	6	ND	c	F (0.71)	Y
Oncometopia facialis	283	43	SD	sa	SF (33.45)	W
Plesiommata corniculata	4	4	ND	d	LF (0.47)	Z
Sonesimia grossa	2	2	ND	d	LF (0.24)	Z
Scopogonalia subolivacea	53	21	D	va	VF (6.26)	Y

1- Dominance (Sakagami and Larroca Method): ND = non-dominant; D = dominant; SD = super dominant; 2 - Abundance: r = rare; d = dispersed; c = common; va = very abundant; sa = super abundant; 3 - Frequency: LF = little frequent, F = frequent; VF = very frequent; SF = super frequent; 4 - Constancy: Z = accidental; Y = accessory; W = constant.

the knowledge about host species and where they occur within or around the citrus-growing property. The host plants present in areas such as forests, woods, and swamps may serve as reservoirs for vectors that could migrate into citrus plants and disseminate the bacterial causal agent of CVC. The results demonstrated that many vector species live in those types of vegetation and migrate into citrus. With this information, it is possible to design specific strategies for sharpshooter management in orchards adjacent to vector refuge sites and therefore prevent transmission of the pathogen.

Acknowledgments

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