A Survey of Sharpshooters (Hemiptera: Cicadellidae) in Virginia Vineyards, a Region of Expanding Concern for Pierce's Disease[1]

Anna K. Wallingford[2] and Douglas G. Pfeiffer

Department of Entomology, Virginia Tech, 216 Price Hall, Blacksburg, Virginia 24061, USA

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Abstract A survey was conducted during the 2006 and 2007 growing seasons to record the presence of sharpshooters (Hemiptera: Cicadellidae) vectors of Pierce's disease in *Vitis vinifera* L. growing regions of Virginia. *Oncometopia orbona* (F.) and *Graphocephala versuta* (Say) were consistently trapped in all regions and throughout each growing season, the latter trapped in the highest number. Peak flight of both species occurred early in the season, the time of greatest concern for introduction of infection. Peak flight of *O. orbona* occurred earlier than that of *G. versuta*. *Homalodisca insolita* (Walker) was trapped in the Coastal Plain of Virginia; this is the most northern record of this species to date.

Key words Pierce's disease, sharpshooters, *Oncometopia orbona*, *Graphocephala versuta*, *Homalodisca insolita*

Pierce's disease is a vascular disease of grapes caused by the xylem-limited bacterium *Xylella fastidiosa* (Wells). The causal agent is transmitted by sharpshooters (xylem-feeding Cicadellidae; Frazier and Freitag 1946), and by some froghoppers (Cercopidae; Severin 1950). Vine decline occurs when xylem fluids are blocked by proliferation of bacterial colonies as well as by plant response to infection (Hopkins 1989, Newman et al. 2003, Stevenson et al. 2005). In mild climates, vine death can occur within 2 - 3 yrs of initial infection (Gubler et al. 2006).

The primary mode of *X. fastidiosa* transmission to grapevines is through sharpshooter feeding (Purcell et al. 1979, Almeida and Purcell 2006). There is little to no latent period between the insect acquiring bacteria and being able to transmit it to a new plant so infection is often seen in those vines within close proximity to infected ones (Severin 1949, Almeida and Purcell 2003). Because sharpshooters overwinter as adults and *X. fastidiosa* can be retained in the mouthparts, the first wave of sharpshooters that emerge in the spring are able to transmit the disease (Freitag and Frazier 1954, Myers et al. 2007). Bacterial colonies are not passed to offspring; therefore, new generations of sharpshooters must feed on infected host plant tissue before becoming a vector themselves (Freitag 1951). Because bacterial colonies are held only on the mouthparts, bacterial colonies are lost with each molt (Purcell and Finlay 1979).

Pierce's disease is a limiting factor in European bunch grape (*Vitis vinifera* L.) production in the southeastern United States, and Virginia lies on the northern edge

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[2] Corresponding author (email: awalling@vt.edu).

of this range. The causal agent is present in all grape-growing areas of the state (Wallingford et al. 2007); however, inland regions are thought to be at low risk of chronic infection as cold winter temperatures prevent chronic bacterial infection of vines (Feil and Purcell 2001). There is concern for Pierce's disease in the midAtlantic states as these winter conditions are less consistent from year to year, and because susceptible varieties, like Chardonnay, Cabernet Franc, Cabernet Sauvignon, represented the majority of bunch grapes grown (Raju and Goheen 1981).

Here, we present a survey of sharpshooter vectors within Virginia vineyards and identify the most abundant sharpshooter species in Virginia vineyards as *Graphocephala versuta* (Say) and *Oncometopia orbona* (F.). We also seek to gain temporal information on the movement of these 2 species into vineyards during the grape-growing season.

Materials and Methods

Ten commercial vineyards were monitored for presence of sharpshooter insects using yellow sticky traps. Two vineyards were monitored in each of 5 geographical regions of Virginia (Fig. 1) growing several varieties of European bunch grapes and representing a range of typical vineyard edge habitats (e.g., deciduous forest, pasture land, residential, agricultural). Yellow sticky traps (22.9 × 27.9 cm unbaited Pherocon AM; Trécé Inc., Adair, OK) were suspended from vineyard training wires, 1 m off the ground, and replaced approx. every 2 wks, April-October 2006 and March-October 2007. Trapping began 1month earlier in 2007 because sharpshooters were captured in April 2006 traps, indicating earlier activity than anticipated. Traps were examined under a dissecting microscope, and sharpshooters were identified to subfamily or species (when possible), counted and preserved in ethanol for systematic identification by the USDA Systematic Identification Laboratory (Beltsville, MD). Voucher specimens are located in the Virginia Tech Insect Collection (Blacksburg, VA).

Because sharpshooter feeding behavior and movement are directed by vine phenology (Mizell and French 1987), trap collection numbers were associated with growing degree days accumulated by the beginning of each trapping period. Growing degree

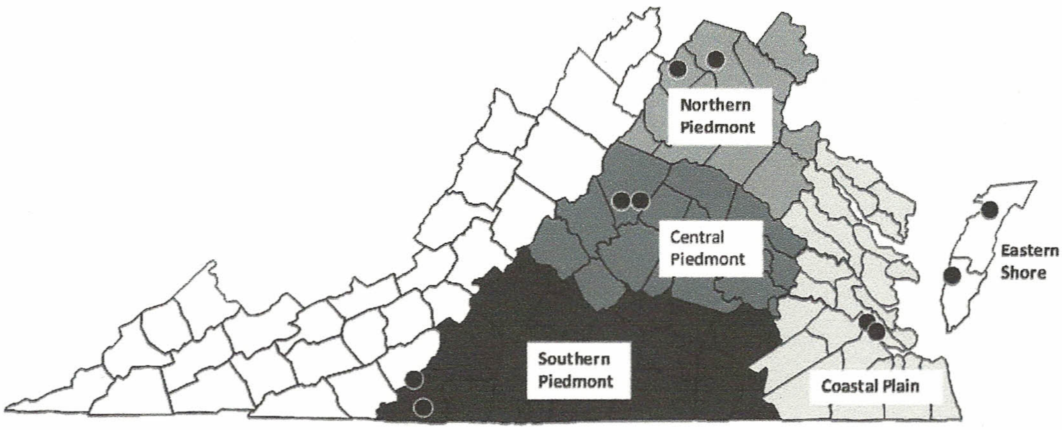

Fig. 1. Locations of vineyards surveyed for sharpshooters in 2006 and 2007.

days (GDD) after January first were calculated from daily minimum and maximum temperatures collected from the nearest NOAA weather station for each location, using 10°C minimum threshold, 32°C maximum threshold.

$$GDD = ((Tmax + Tmin)/2) - 10°C$$

A Student's *t*-test was conducted using JMP (SAS Institute Inc. 2007) to test for significantly greater number of GDD accumulated at each site by peak flight of *O. orbona* versus that of *G. versuta* and also to test for significant difference in total number of individuals trapped during peak flight ($n = 10$, $\alpha = 0.05$).

Results and Discussion

Pierce's disease vectors were present in every grape-growing region of Virginia, and their presence is recorded in the beginning of the growing season, the most susceptible time for introduction of *X. fastidiosa*. Several species of known and potential Pierce's disease vectors were trapped at every collection site in 2006 and 2007 (Table 1). The most consistently trapped species were *G. versuta* and *O. orbona;* these 2 species made up the largest percentage of all potential vector species trapped. *Homalodisca insolita* (Walker) was trapped in the Coastal Plain in 2007 and has been observed in yellow sticky traps in subsequent studies in the same region. This is the most northern record of this species, a congener to glassy-winged sharpshooter (*H. coagulata*) which is the primary native vector species of Pierce's disease in states south of North Carolina (Almeida and Purcell 2003).

Both *O. orbona* and *G. versuta* were first trapped by grapevine bud break in early April in 2006 and 2007. Peak capture of *O. orbona* occurred midMay to end of June, but this species was rarely trapped after July. Peak capture of *G. versuta* occurred June through August and was observed in traps throughout the season until the end of the collection period. Peak capture of *O. orbona* occurred earlier than that of *G. versuta*; growing degree days accumulated at peak capture of *O. orbona* was less than that of peak capture of *G. versuta* in both years (Table 2). More *G. versuta* were trapped than *O. orbona* in both years (Table 2).

Only one peak in insect density was seen for each species although laboratory populations of both *O. orbona* and *G. versuta* were found to complete at least 2 and 3 generations per year, respectively (Turner and Pollard 1959). It is possible that subsequent generations migrate to other host plants outside of vineyard space. The timing of peak flights may indicate that the *O. orbona* trapped in the vineyard at peak flight are mainly overwintered individuals. It is possible that those *G. versuta* trapped at peak flight were mainly the first generation. Based on developmental rates from Turner and Pollard (1959) there were enough growing degree days experienced at most sites for *G. versuta* to have developed from an egg to adult between the first observation in traps until the peak number observed in traps.

Early season transmission of *X. fastidiosa* is of greatest concern because a higher proportion of vectors are infective, and also because an early introduction of *X. fastidiosa* allows for more time in the growing season for bacterial colonies to proliferate within xylem vessels and a greater probability of chronic infection leading to vine death (Purcell 1981). As of yet, the best management practice for growers is

Table 1. Sharpshooters (xylem-feeding Cicadellidae) by subfamily captured in yellow sticky traps (1 m height) in *V. vinifera* vineyards, total number of individuals trapped by year and % of that total by year.

		2006		2007	
Subfamily	Species	Total	% of total	Total	% of total
Cicadellinae	*Cuerna* spp.**	1	0.01	0	0.00
	Draeculacephala spp.*	13	0.11	9	0.06
	Graphocephala coccinea (Forster)**	72	0.61	60	0.39
	Graphocephala versuta (Say)*	9719	82.81	12924	84.67
	Homalodisca insolita (Walker)*	0	0.00	3	0.02
	Oncometopia orbona (Fabr.)*	811	6.91	401	2.63
	Paraulacizes spp.	61	0.52	36	0.24
	Sibovia spp.	2	0.02	3	0.02
Agallinae	*Agallia* spp.	485	4.13	698	4.57
Aphrodinae	*Aphrodes* spp.	2	0.02	7	0.05
Deltocephalinae	*Colladonus* spp.	12	0.10	8	0.05
	Osbornellus spp.	20	0.17	42	0.28
	Paraphlepsius spp.**	284	2.42	163	1.07
	Penthimia americana (Fitch)	1	0.01	4	0.03
	Scaphytopius spp.	147	1.25	589	3.86
Coelidinae	Unknown	69	0.59	165	1.08
Gyponinae	Unknown	38	0.32	152	1.00

* documented Pierce's disease vector.
** potential Pierce's disease vector (documented to carry *Xylella fastidiosa* but transmission not confirmed).

removal of infected vines in the fall and the use of insecticides to protect vines from bud break through early summer, particularly following one or more mild winters (Gubler et al. 2006).

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Table 2. Mean total (± SE) of *G. versuta* and *O. orbona* collected during the trapping period at peak capture, as well as the mean number (± SE) of growing degree days (GDD) accumulated by the beginning of that trapping period in 2006 and 2007.

	mean total at peak		mean GDD at peak	
Species	**2006**	**2007**	**2006**	**2007**
G. versuta	474.6 ± 167.2	642.0 ± 190.0	1437.0 + 83.8	1558 + 212.5
O. orbona	40.3 ± 13.5	21.4 ± 6.5	799.0 + 70.0	868 + 66.7
t	2.58	3.26	5.84	3.1
df	9, 9.11	9, 9.02	9, 17.44	9, 10.75
p	0.0146	0.0049	< 0.0001	0.0052

Significant difference determined by Student's *t*-test using JMP ($n = 10$).

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