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The First Detection of Leafhopper *Scaphoideus titanus* Ball (Hemiptera, Cicadellidae) in Slovakia

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Abstract

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Scaphoideus titanus Ball, the main vector of Flavescence dorée phytoplasma, was monitored in Slovakia during 2013 and 2014. The species was present in the vineyards of eastern Slovakia but it was rarely found in the south of central part of the country. It was also found at many locations of western Slovakia but not in the southeast of western Slovakia. Higher abundance of *S. titanus* was detected in the vineyards with biological control. Varietal preference of the leafhopper was not confirmed. The first nymphs were found on June 5 and the last nymphs on July 17, adults occurred from the end of June to the end of September. There is one generation of *S. titanus* per year in Slovakia.

Keywords: American grapevine leafhopper; occurrence; phenology; Flavescence dorée

The Nearctic leafhopper, *Scaphoideus titanus* Ball, 1932 (Hemiptera: Cicadellidae: Deltocephalinae), the main vector of Flavescence dorée phytoplasma, native to North America, was accidentally introduced into Europe in the 1950s (Schvester *et al.* 1969).

The first incidence of *S. titanus* in Europe was reported from the vineyards of France in 1958 (Bonfils & Schvester 1960). Nearly at the same time it was also reported from Italy (Vidano 1964) and Switzerland (Baggiolini *et al.* 1968). The species continued to spread into Yugoslavia (Seljak 1987), Spain (Batlle *et al*. 1997), Portugal (Quartau *et al*. 2001), Austria (Zeisner 2005; Steffek *et al*. 2006), Hungary (Dér *et al*. 2007), Romania (Chireceanu *et al*. 2011), and Bulgaria (Avramov *et al*. 2011). The long-distance spread of *S. titanus* is caused mainly by human activities and all European vineyards are susceptible to be colonised (Chuche & Thiéry 2014).

S. titanus is monovoltine and it overwinters as eggs laid in the previous summer in two-year old grapevine canes (Vidano 1964). In northern Italy, the seasonal flight peak occurred each year in different periods, ranging from the end of June to the beginning of July, depending on mean temperature values (Lessio & Alma 2004). The peak of male presence was recorded in the middle of July in sweep net and in the middle of August on sticky traps. The maximum presence of females in sweep net samplings and on sticky traps was detected at the end of August (Lessio *et al*. 2009).

Although occurrence of *S. titanus* and its population dynamics was well examined in many countries of Europe, in Slovakia these data were absent. Thus, the aim of this study was to detect possible presence and describe life cycle of *S. titanus* in Slovakia.

MATERIAL AND METHODS

Branch beating method (50 beatings in each of 3 repetitions) was used to collect nymphs and adults of *S. titanus* in weekly intervals in order to determine its occurrence at regularly monitored location – Vinohrady nad Váhom. The same method was used to monitor the leafhopper distribution in all

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wine-growing regions of Slovakia and two locations of Hungary (Tables 1–5).

S. titanus individuals were also captured using yellow, white, and transparent sticky traps (size of the sticky part 10 × 10 cm; produced by BioTomal s.r.o., Rúbaň, Slovakia). In 2013, traps were installed in four locations: Strekov and Marcelová in south-western Slovakia and Tata and Győr in north-western Hungary (Tables 3 and 4). In 2014, the fifth location (Vinohrady nad Váhom) was included in the study (Table 5). Six traps were placed at each location, three in vineyards with chemical management and three in vineyards managed with biological control. Traps were placed vertically on the plants during the whole flight period (from June to September) in two-week intervals and checked one week after installation.

RESULTS

In eastern Slovakia, *S. titanus* was present in major regions of wine-growing including warm south-east as well as in the colder region of Sobrance (Table 1). The species was rare in the south of central Slovakia and there was only one specimen found after searching at 7 localities (Table 2). The leafhopper was frequent at many locations of western Slovakia but it was not found in the southeast of western Slovakia (Table 3) and in the corresponding part of north-western Hungary (Table 4).

Compared to the other locations studied, higher numbers of the leafhopper were found at Vinohrady nad Váhom. The numbers were higher in the vineyard with biological control (Table 5). It was confirmed by Mann-Whitney test for numbers of adults in yellow sticky traps (P = 0.0309) or number of adults collected by branch beating (P = 0.000058).

Adults of *S. titanus* were collected from many different vine varieties (Tables 2 and 3). If the species was present at a given location, the specimens were usually collected from all vine varieties. The numbers of collected individuals were too low to make a decision about varietal resistance or susceptibility.

The first nymphs were found on June 5, the last on July 17 at the location Vinohrady nad Váhom (Table 5). Adults occurred from June 26, over August and September. Major part of the adults were caught in yellow sticky traps while most of nymphs were caught in white sticky traps. Transparent sticky traps were less attractive for both mobile developmental stages. Kruskal-Wallis test confirmed significant differences in numbers of adults caught to yellow and white sticky traps (P = 0.014528), yellow and transparent sticky traps (P = 0.000001), and white and transparent sticky traps (P = 0.00266). The highest numbers of the leafhopper were found in yellow sticky traps collected on July 31 (9 specimens in three traps), on August 14 (16 specimens in three traps), and on September 11 (31 specimens in three traps).

Table 1. Locations in eastern Slovakia where branch beating (3 × 50) was performed

Location	Coordinates	*n*	Date
Černochov (T)	48°26'21"N 21°43'00"E	2 2	08/08/2014
Malá Tŕňa (T)	48°26'60"N 21°41'14"E	1	
Streda nad Bodrogom (E)	48°02'26"N 21°46'37"E	2 1	
Strážne (E)	48°22'35"N 21°49'28"E	8 2 1	
Jablonov nad Turňou (E)	48°35'53"N 20°41'04"E	0	
Zádiel (E)	48°36'35"N 20°50'50"E	0	
Hlivištia (E)	48°47'59"N 22°13'21"E	0	22/08/2014
Horňa (E)	48°45'54"N 22°12'53"E	2	

T – Tokaj viticulture region; E = East-Slovakian viticulture region; *n* – number of collected *Scaphoideus titanus* adults

Table 2. Locations in the south of Central Slovakia (Central-Slovakian viticulture region) where branch beating (3 × 50) was performed

Location	Coordinates	*n*	Date	Variety
Hajnáčka	48°14'08"N 19°56'25"E	0	08/08/2014	–
Kosihovce	48°10'49"N 19°11'33"E	0		–
Čebovce	48°11'14"N 19°14'15"E	0	16/08/2014	Devín
Príbelce	48°11'34"N 19°15'13"E	0		Green Veltliner
Bušince	48°10'49"N 19°28'48"E	0		Chardonnay
Veľký Krtíš 1 (biological control)	48°13'00"N 19°20'43"E	0		Hron
	48°13'01"N 19°20'40"E	1		Pinot Blanc

n – number of collected *Scaphoideus titanus* adults

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Table 3. Locations in western Slovakia where branch beating (3 × 50) was performed

Location	Coordinates	*n*	Date	Variety
Šalov (W1)	48°00'54''N; 18°43'35''E	0	08/08/2014	–
Vráble (W1)	48°15'21''N; 18°17'11''E	0	01/08/2014	Müller-Thurgau
		5		Green Veltliner
		4		Saint Laurent
Strekov 1 (W2) (biological control)	47°54'60''N; 18°25'22''E	0	July, August 2013 and 2014, weekly**	Dunaj
Strekov 2 (W2) (chemical control)	47°55'02''N; 18°25'26''E	0		Green Veltliner
Marcelová 1 (W2) (biological control)	47°49'10''N; 18°17'53''E	0		Bouvier
Marcelová 2 (W2) (chemical control)	47°48'57''N; 18°17'47''E	0		Pálava
Búč (W2)	47°48'48''N; 18°24'50''E	0	18/08/2014	Cabernet Sauvignon
		0		Cabernet Sauvignon
		0		Blauer Limberger
		0		Blauer Limberger
Moča (W2)	47°45'58''N; 18°24'38''E	0		Pinot griss
		0		Pinot griss
		0		Riesling
		0		Riesling
Šamorín (W2)*	48°02'08''N; 17°18'28''E	3	16/08/2014	Riesling
		3		Blauer Limberger
		0		Zwaigelt
Vinohrady nad Váhom 1 (W3) (biological control)	48°18'23''N; 17°46'34''E	8	31/07/2014	Pinot Blanc
Vinohrady nad Váhom 2 (W3)	48°18'21''N; 17°46'35''E	1		Riesling
Hlohovec (W3)	48°24'30''E; 17°47'7''E	2	16/08/2014	Blauer Limberger
		1		Green Veltliner
Pezinok (W3)	48°18'52''N; 17°19'42''E	4	15/08/2014	Pinot griss
		3		Traminer
		1		Pálava
		9		Riesling
		1		Pinot Noir
		4		Blauer Limberger
		3		Merlot
		8		Alibernet
Dolné Orešany (W3)	48°25'24''N; 17°26'8''E	1		Riesling
		1		Green Veltliner
	48°27'10''N; 17°28'8''E	1		Dornfelder
Dechtice (W3)	48°33'6''N; 17°35'2''E	0		Pinot Blanc
		0		Riesling
		0		Red Veltliner
Skalica (W3)	48°50'50''N; 17°14'31''E	1		Müller-Thurgau
		1		Blauer Portugieser
		1		Blauer Limberger
		0		Saint Laurent

n = number of collected *Scaphoideus titanus* adults; W1 = north-east of western Slovakia (Nitra viticulture region), W2 = south of western Slovakia (South-Slovakian viticulture region); W3 = west of western Slovakia (Small Carpathian viticulture region); *location Šamorín is situated in the west of the South-Slovakian viticulture region; **at these locations also yellow, transparent, and white sticky traps were installed

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Table 4. Locations in north-western Hungary where branch beating (3 × 50) and yellow, transparent, and white sticky trapping was performed

Location	Coordinates	*n*	Date	Variety
Tata 1	47°39'24"N; 18°16'50"E	0	July, August 2013 and 2014, weekly	Zenith
Tata 2 (biological control)	47°39'17"N; 18°15'48"E	0		Cserszegi Fűszeres
Győr 1 (biological control)	47°34'08"N; 17°37'40"E	0		Ezerfürtű White
Győr 2	47°34'21"N; 17°37'28"E	0		Ezerfürtű White

n = number of collected *Scaphoideus titanus* adults

DISCUSSION

After the survey in Hungary it was emphasized that *S. titanus* spread from the southern border of Hungary to the eastern wine growing regions (Orosz & Zsolnai 2010). We did not find *S. titanus* in these parts of Danube region (in the south-west of Slovakia and the north-east of Hungary), but its occurrence was usually more frequent at colder regions of vine production in Slovakia. The explanation for this situation cannot lie within the way of vineyard management because monitoring of the insect was done both in vineyards managed with biological and chemical control. In Europe, *S. titanus* was found in vineyard areas under different climatic conditions but it was more abundant in the eastern and northern parts of viticulture region rather than in the south and the Mediterranean vineyards (Boudon-Padieu 2000).

The results from Vinohrady nad Váhom indicate that numbers of *S. titanus* are higher in vineyards with biological control of pests and pathogens but *S. titanus* was found also in the vineyards managed with usual plant protection practice. This supports the opinion that usual plant protection practice cannot prevent the establishment and spread of vector populations, especially in sustainable production systems (Steffek *et al.* 2006). The efficiency of any insecticide treatment is disputable. Insecticide treatments contributed to very low leafhopper population levels (Riolo *et al.* 2014). In organic farming, pyrethrum was effective in the control of nymphs (Gusberti *et al.* 2008) and adults (Bottura *et al.* 2003). On the other hand, it appears that under particular wind conditions the vector can fly to vineyards several kilometres away from infested sites (Steffek *et al.* 2006). Nevertheless, in many vine-growing areas there are also untreated or abandoned vineyards or wild *Vitis* species (Bressan *et al.* 2005) from where *S. titanus* is capable of dispersing to cultivated grapevine (Lessio *et al.* 2014). Inter-row vegetation can be also inhabited by *S. titanus* (Trivellone *et al.* 2013).

We found that if the leafhopper was present at certain location, it was usually collected from all vine cultivars. It seems that although occurrence of *S. titanus* is important, more important is the susceptibility of vine varieties to Flavescence dorée

Table 5. Numbers of *Scaphoideus titanus* nymphs (N) and adults (A) caught to yellow (YST), white (WST), and transparent sticky traps (TST) plus numbers of specimens caught by beatings (B). Numbers show the sum of collected specimens in three traps and in 3 × 50 branch beatings (Location Vinohrady nad Váhom, Slovakia, 2014)

Vineyard	Method	Date																
		5/6	12/6	19/6	26/6	3/7	10/7	17/7	24/7	31/7	7/8	14/8	21/8	28/8	04/9	11/9	17/9	24/9
Pinot Blanc (biological control)	YST	–	0	–	1A	1N	–	3A	–	9A	–	16A	–	7A	–	31A	–	2A
	WST	–	0	–	6N	2N	–	1A; 5N	–	5A	–	9A	–	4A	–	10A	–	0
	TST	–	0	–	2N	3N	–	0	–	0	–	0	–	0	–	1A	–	0
	B	1N	2N	5N	4N	0	3A; 6N	23A; 1N	6A	8A	2A	5A	9A	7A	11A	9A	2A	1A
Riesling (chemical control)	YST	–	0	–	0	0	–	0	–	2A	–	8A	–	4A	–	16A	–	0
	WST	–	0	–	0	0	–	0	–	1A	–	0	–	2A	–	2A	–	0
	TST	–	0	–	0	0	–	0	–	0	–	0	–	0	–	0	–	0
	B	0	0	1N	0	0	0	1A	0	1A	1A	1A	0	1A	1A	0	0	0

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phytoplasma. There are vine cultivars able to recover (Merlot) and also the cultivars where the course of the disease is frequently lethal (Pavan *et al*. 2012).

According to our results (Slovakia, location Vinohrady nad Váhom), the first nymphs of *S. titanus* were captured on June 5 and the last nymphs were present on July 17. The first adults were found on June 26 and the adults were collected from plants during August and September. In the north of Italy, egg hatching usually starts in the middle of May and ends in July. The nymphs have five instars, each instar lasts a week. The adults are present from the end of June until the middle of October (Vidano 1964). We suppose that in Slovakia egg hatching started in the middle of May and continued until the end of July. In Romania the nymphs were recorded from June to July in 2009, or until August in 2010 and even up to September in 2011. The activity of adults started at the end of June in 2009 and at the beginning of July in 2010 and 2011. The flight of adults usually lasted until the middle of October (Chireceanu 2014). From these results it seems that in warm locations of Europe the insect might have more than one generation. However, figures from Romania did not show distinct second peak of nymph population. Chuche and Thiéry (2014) suppose that individuals from the second generation have no time enough to develop into adults in European vineyards. The second generation also does not seem to be developed in Slovakia and we assume that there is only one generation per year in the country.

In Bordeaux (France), three adults per yellow sticky trap during one week were established as a threshold for the pest control (Chuche & Thiéry 2014). Numbers of collected specimens exceeded these threshold values also in the Slovakian location (Table 5).

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