

WHITEFLY SPECIES (Hemiptera: Aleyrodidae) RECORDED ON IMPORTED ORNAMENTAL PLANTS IN CROATIA FROM 2005–2008

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ABSTRACT

During the last decade worldwide trade in plants has increased enormously. Because of increased import of different ornamentals in the last years, possibility of interception of new whitefly species has increased too. That was the main reason of inspections of imported ornamental plants in the nurseries and greenhouses carried out over a 4 year period (2005 – 2008). It was collected 152 leaf samples. Whiteflies were collected using the visual survey of host plant leaves on presence of their puparia or pupal cases. All collected whiteflies in leaf samples were identified to the species level. Inspections carried out on consignments originating from 5 European countries, mostly from The Netherlands, and also from Japan, have resulted in 9 identified whitefly species: *Aleuroclava hikosanensis* Takahashi, 1938, *Aleuroclava jasmini* Takahashi, 1932, *Aleurothrixus floccosus* Maskell, 1896, *Aleyrodes elevatus* Silvestri, 1934, *Bemisia afer* Priesner & Hosny, 1934, *Bemisia tabaci* Gennadius, 1889, *Dialeurodes citri* Ashmead, 1885, *Massilieuodes chittendeni* Laing, 1928 and *Trialeurodes vaporariorum* Westwood, 1856. The species which has the highest distribution of frequency was *T. vaporariorum*. It was present in the most of collected leaf samples. The next most frequent species was *B. tabaci*, the species recently introduced to Croatia. Species *A. elevatus* and *D. citri* are already well established in the nature in coastal part of Croatia. Species *B. afer* is an indigenous species widespread throughout the country. Species *A. floccosus* is currently present only on limited area of Croatian Middle Adriatic region. Species *A. hikosanensis*, *A. jasmini* and *M. chittendeni* are newly recorded species for Croatia. These are all non European whitefly species. Only the species *M. chittendeni*, which probably originates in northern Asia is distributed in some European countries. Their possibility of naturalization in Croatia is not known. For this reason, a Pest Risk Analysis for these pests is strongly suggested.

Key words: Aleyrodidae, Croatia, imported ornamentals, whiteflies

1 INTRODUCTION

Whiteflies belong to the order Hemiptera and comprise a single superfamily, Aleyrodoidea, within the suborder Sternorrhyncha. They are all placed in a single family, Aleyrodidae, and are small sap-sucking, usually inconspicuous insects. An updated latest check list of the world's extant whitefly species comprises 1556 species from 161 genera (Martin & Mound, 2007). According to Martin *et al.* (2000) the whitefly fauna of Europe and the Mediterranean Basin comprises 56 species that are considered to be native or naturalized, accommodated within 25 genera.

Whiteflies are very important pests of numerous agricultural crops. In Europe, they cause the highest economical damages on vegetable and ornamental plant species, especially in greenhouses as well as on citrus. They are also the pests of different trees and shrubs.

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During the last decade worldwide trade in plants has increased enormously. Because of increases import of different ornamentals in the last years, possibility of interception of new whitefly species has increased too. That was the main reason of inspections of imported ornamental plants on presence of whiteflies in the nurseries and greenhouses, carried out from 2005-2008. Inspections carried out on consignments originating from European countries, and also from Japan, have resulted in 9 identified whitefly species.

2 MATERIALS AND METHODS

Inspections of imported ornamental plants on presence of whiteflies were carried out in the nurseries and greenhouses in Croatia in period 2005-2008. Whiteflies were collected with the use of a visual survey of host plant leaves with the help of a magnifying lens of 10 x magnification for the presence of puparia or pupal cases. Host plants were identified and systematized according to Wickham (1977), Šilić (1990) Noordhuis (1993), Quattrocchi (2000) and Yamamori & Taaffe (2004), but also for some of them our own observations were used. The leaf samples were placed and stored by the dry method in an envelope until whitefly preparation (Martin, 1987; 1999).

All collected whiteflies in leaf samples were identified to the species level on the basis of morphological characters of puparium and/or pupal case, using the classical identification method according to relevant morphological keys. Whitefly puparia and pupal cases were slide-mounted in Canada balsam as permanent microscopic slides according to a modified Watson & Chandler (1999) method and labelled with all data relevant for faunistic entry. For the identification the following keys were used: Takahashi (1952; 1954), Mound (1966), Habib & Farag (1970), Martin (1985; 1987; 1999), Bink-Moenen & Gerling (1990), Mifsud (1995) and Martin *et al.* (2000). For an accurate identification, a stereomicroscope (Nikon SMZ 800) and a compound microscope (Olympus BX 50) were employed.

The localities of finding of recorded whitefly species were marked using geography coordinates and according to the Universal Transverse Mercator coordinate system (Horvat *et al.*, 2003). Verification of all identifications of whitefly species recorded by investigations was done by M.G.M. Jansen (Plant Protection Service, Wageningen, The Netherlands).

3 RESULTS AND DISCUSSION

Inspections of imported ornamental plants on presence of whiteflies during four years investigations (2005-2008) were conducted on totally 15 localities in 10 counties of Republic of Croatia. Total number of analysed whitefly samples collected from plant material was 152 on 52 different species of host plants from 31 families. Inspections were carried out on consignments originating from 5 European countries (Hungary, Italy, The Netherlands, Portugal and Spain) and also from one non European country, Japan (Figure 1). The most consignments were originated from The Netherlands (79,61 %), what is understandable, because it is the most significant exporter of ornamental plants for Croatia.

The microscopic identification of whiteflies recorded on collected plant leaves resulted in 9 identified species from 7 different genera: *Aleuroclava hikosanensis* Takahashi, 1938, *Aleuroclava jasmini* Takahashi, 1932, *Aleurothrixus floccosus* Maskell, 1896, *Aleyrodes elevatus* Silvestri, 1934, *Bemisia afer* Priesner & Hosny, 1934, *Bemisia tabaci* Gennadius, 1889, *Dialeurodes citri* Ashmead, 1885, *Massilieuodes chittendeni* Laing, 1928 and *Trialeurodes vaporariorum* Westwood, 1856 (Figure 2).

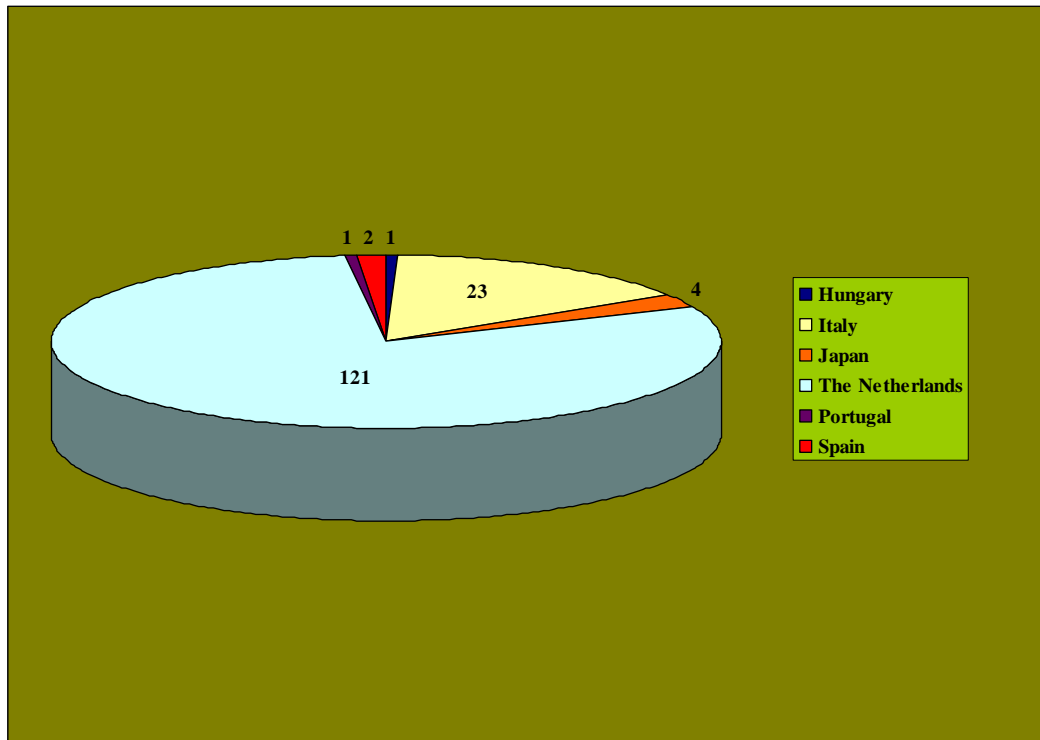


Fig. 1: Origin of imported plant material and number of samples in which whiteflies were recorded (2005-2008).

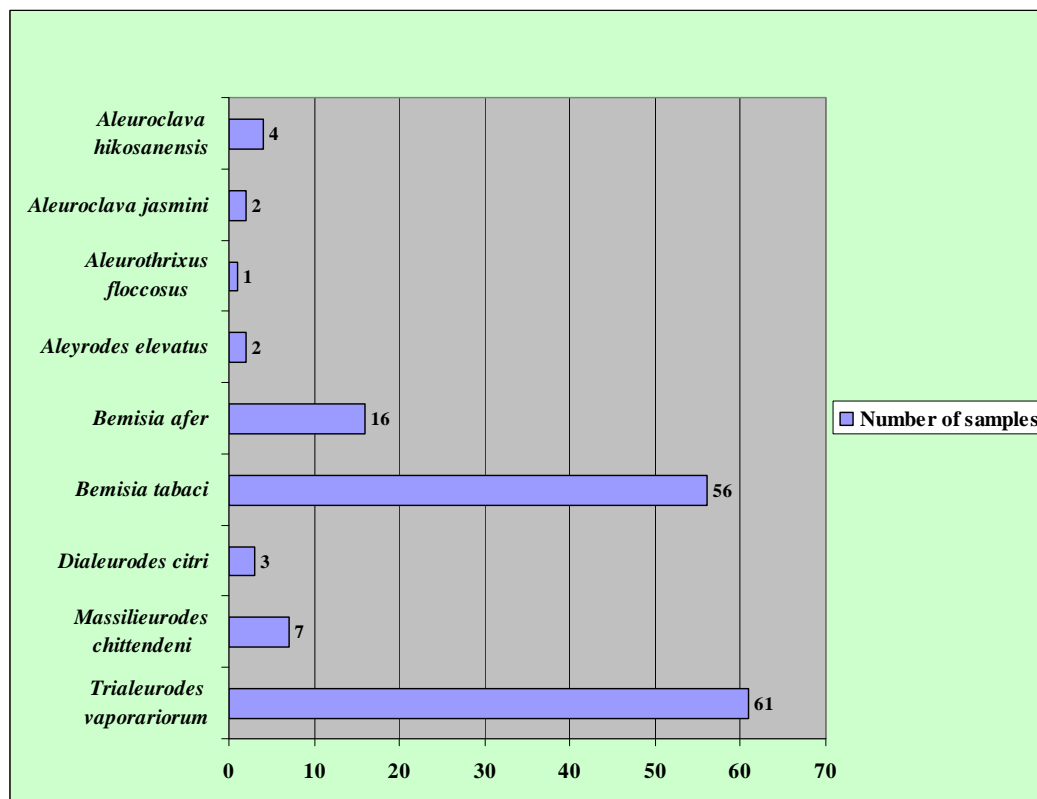


Fig. 2: Whitefly species identified in imported consignments (2005-2008).

T. vaporariorum, often called the glasshouse whitefly, was present in most of 152 collected samples. This cosmopolite and extremely polyphagous pest species was detected in 40,13 % of the leaf samples (Figure 2). It is the most common and widespread whitefly species in Croatia (Šimala, 2008). The next most frequent species was recently introduced to Croatia, *B. tabaci* (Žanić *et al.*, 2001). It was identified during the inspections in 36,84 % of the analysed leaf samples (Figure 2) on 13 localities (Table 1). *B. tabaci* possibly originated in India (Fishpool & Burban, 1994) and as a result of widespread dispersal, particularly during the last 20 years, it is now distributed nearly worldwide.

Table 1: Finding places of recorded whitefly species in imported plant material (2005-2008).

WHITEFLY SPECIES	LOCALITY	GEOGRAPHY COORDINATE	UTM
<i>Aleuroclava hikosanensis</i>	Lučko	45°45'43" N 15°53'48" E	33T WL6867
	Turanj	43°58'10" N 15°24'26" E	33T WJ3368
<i>Aleuroclava jasmini</i>	Lučko	45°45'43" N 15°53'48" E	33T WL6867
	Pula	44°52'07" N 13°50'58" E	33T VK0969
<i>Aleurothrixus floccosus</i>	Turanj	43°58'10" N 15°24'26" E	33T WJ3368
<i>Aleyrodes elevatus</i>	Dubrovnik	42°39'13" N 18°05'42" E	34T BN6126
	Pula	44°52'07" N 13°50'58" E	33T VK0969
<i>Bemisia afer</i>	Lučko	45°45'43" N 15°53'48" E	33T WL6867
	Metković	43°03'04" N 17°39'05" E	33T YH1670
	Pula	44°52'07" N 13°50'58" E	33T VK0969
	Split	43°30'45" N 16°26'32" E	33T XJ1919
	Turanj	43°58'10" N 15°24'26" E	33T WJ3368
	Umag	45°25'52" N 13°31'26" E	33T UL8432
	Varaždin	46°18'41" N 16°20'16" E	33T XM0329
	Zagreb	45°47'39" N 15°57'27" E	33T WL7772
<i>Bemisia tabaci</i>	Dubrovnik	42°39'13" N 18°05'42" E	34T BN6126
	Gaženica	44°05'29" N 15°16'07" E	33T WJ2281
	Knežine	43°32'26" N 16°18'34" E	33T XJ0722
	Lučko	45°45'43" N 15°53'48" E	33T WL6867
	Magadenovac	45°32'30" N 17°57'22" E	34T BR8160
	Metković	43°03'04" N 17°39'05" E	33T YH1670
	Pula	44°52'07" N 13°50'58" E	33T VK0969
	Split	43°30'45" N 16°26'32" E	33T XJ1919
	Štefanec	46°22'22" N 16°29'45" E	33T XM1536
	Turanj	43°58'10" N 15°24'26" E	33T WJ3368
	Umag	45°25'52" N 13°31'26" E	33T UL8432
	Ušići Dvori	44°52'51" N 13°57'47" E	33T VK1773
	Zagreb	45°47'39" N 15°57'27" E	33T WL7772
	<i>Dialeurodes citri</i>	Pula	44°52'07" N 13°50'58" E
<i>Massilieuodes chittendeni</i>	Lučko	45°45'43" N 15°53'48" E	33T WL6867
	Split	43°30'45" N 16°26'32" E	33T XJ1919
	Štefanec	46°22'22" N 16°29'45" E	33T XM1536
<i>Trialeurodes vaporariorum</i>	Dubrovnik	42°39'13" N 18°05'42" E	34T BN6126
	Lučko	45°45'43" N 15°53'48" E	33T WL6867
	Magadenovac	45°32'30" N 17°57'22" E	34T BR8160
	Metković	43°03'04" N 17°39'05" E	33T YH1670
	Novaki	45°38'40" N 15°37'07" E	33T WL4337
	Pula	44°52'07" N 13°50'58" E	33T VK0969
	Split	43°30'45" N 16°26'32" E	33T XJ1919
	Turanj	43°58'10" N 15°24'26" E	33T WJ3368
	Ušići Dvori	44°52'51" N 13°57'47" E	33T VK1773
	Varaždin	46°18'41" N 16°20'16" E	33T XM0329
Zagreb	45°47'39" N 15°57'27" E	33T WL7772	

Another broadly polyphagous species from genus *Bemisia*, *B. afer* was frequent and was recorded in 10,53 % of the leaf samples taken from imported ornamental plants (Figure 2). *B. afer* has been detected on several occasions on imported plant material in Croatia, but only on bay plants (*Laurus nobilis* L.) from Italy and Spain (Table 2).

Table 2 Host plants of recorded whitefly species in imported plant material (2005-2008).

WHITEFLY SPECIES	PLANT FAMILY	PLANT SPECIES	YEAR OF FINDING
<i>Aleuroclava hikosanensis</i>	Aquifoliaceae	<i>Ilex crenata</i> Thunb.	2005, 2006, 2007
<i>Aleuroclava jasmini</i>	Rubiaceae	<i>Gardenia jasminoides</i> Ellis	2007
<i>Aleurothrix floccosus</i>	Rutaceae	<i>Citrus limonum</i> L.	2008
<i>Aleyrodes elevatus</i>	Moraceae	<i>Ficus carica</i> L.	2007, 2008
<i>Bemisia afer</i>	Lauraceae	<i>Laurus nobilis</i> L.	2005, 2006, 2007, 2008
<i>Bemisia tabaci</i>	Acanthaceae	<i>Crossandra buntingii</i> S. Moore	2006
	Apocynaceae	<i>Dipladenia</i> A. DC. sp.	2007
		<i>Mandevilla</i> sp.	2008
		<i>Nerium oleander</i>	2005
		Asteraceae	<i>Helianthus annuus</i> L.
	Bignoniaceae	<i>Campsis radicans</i> (L.) Seem.	2005, 2008
	Euphorbiaceae	<i>Acalypha hispida</i> Burm. f.	2007
		<i>Euphorbia milii</i> Desmoul	2005, 2006
		<i>Ricinus communis</i> L.	2005
	Labiatae	<i>Ajuga reptans</i> L.	2005
		<i>Callicarpa bodinieri</i> H. Leveille	2007
	Malvaceae	<i>Abutilon</i> Miller x <i>hybridum</i> hort.	2005, 2008
		<i>Abutilon striatum</i> G. Dickson ex Lindl.	2005
		<i>Hibiscus rosa sinensis</i> L.	2005, 2006, 2007, 2008
	Moraceae	<i>Ficus benjamina</i> L.	2005, 2008
	Myrtaceae	<i>Agonis flexuosa</i> (Willd.)	2007
<i>Eucalyptus gunni</i> Hook. f.		2008	
Rutaceae	<i>Citrus limonum</i> L.	2007	
Ulmaceae	<i>Ulmus</i> sp.	2008	
<i>Dialeurodes citri</i>	Rubiaceae	<i>Gardenia jasminoides</i> Ellis	2005, 2007
<i>Massilieuodes chittendeni</i>	Ericaceae	<i>Rhododendron</i> L. hybride	2007, 2008
		<i>Rhododendron simsii</i> (Pla.)	2005
<i>Trialeurodes vaporariorum</i>	Anacardiaceae	<i>Cotinus</i> Miller sp.	2007
	Asteraceae	<i>Dendranthema x grandiflorum</i> Kitam	2005
		<i>Gerbera jamesonii</i> Bolus ex Adlam	2005, 2008
		<i>Helianthus annuus</i> L.	2005, 2008
	Buddlejaceae	<i>Buddleja davidii</i> (Franchet)	2005
	Campanulaceae	<i>Laurentia</i> Adans. sp.	2007
		<i>Platycodon grandiflorus</i> Astra (Jacq.)	2005, 2008
	Caprifoliaceae	<i>Viburnum opulus</i> L.	2006
	Ericaceae	<i>Azalea indica</i> L.	2005, 2007, 2008
		<i>Vaccinium corymbosum</i> L.	2005
	Euphorbiaceae	<i>Euphorbia</i> L. sp.	2007
	Fabaceae	<i>Medicago lupulina</i> L.	2005
<i>Sophora subprostrata</i> Chun & Chen		2005	

Hydrangaceae	<i>Philadelphus</i> L. sp.	2005
Labiatae	<i>Callicarpa bodinieri</i> H. Leveille	2007
Lauraceae	<i>Laurus nobilis</i> L.	2005
Magnoliaceae	<i>Magnolia</i> L. sp.	2007
Malvaceae	<i>Hibiscus rosa sinensis</i> L.	2005, 2006, 2008
	<i>Hibiscus syriacus</i> L.	2006, 2007, 2008
	<i>Lavatera</i> L. sp.	2007
Myrtaceae	<i>Eucalyptus camaldulensis</i> (Dehnh.)	2005
	<i>Eucalyptus gunni</i> Hook. f.	2005
Nyctaginaceae	<i>Bougainvillea spectabilis</i> (Willd.)	2005
Punicaceae	<i>Punica granatum nana</i> L.	2005
Rosaceae	<i>Spirea x vanhouttei</i> (Briot.) Zbl.	2007
Rubiaceae	<i>Gardenia jasminoides</i> Ellis	2006
Salicaceae	<i>Salix</i> L. sp.	2005
Saxifragaceae	<i>Bergenia</i> Moench sp.	2007
Scrophulariaceae	<i>Paulownia tomentosa</i> Thunberg Steu.	2005
Solanaceae	<i>Brugmansia suaveolens</i> Willd.	2005
	<i>Solanum melongena</i> L.	2005
Streculiaceae	<i>Brachichiton acerifolius</i> Macarthus	2005
Verbenaceae	<i>Lantana camara</i> L.	2005

In the puparial stage, *B. afer* is the whitefly species most likely to be confused with *B. tabaci* during phytosanitary inspection. *B. afer* is widespread in the tropics and subtropics. According to Martin *et al.* (2000), *B. tabaci* and *B. afer* are the only two species of genus *Bemisia* recorded in Europe and the Mediterranean. In Croatia, *B. afer* is widespread throughout the country on numerous, mostly dicotyledonous woody host plant species (Šimala, 2008). The citrus whitefly, *D. citri* was detected on leaves of imported *Gardenia jasminoides* Ellis in 3 samples (Figure 2). This is a very rare host plant for this species, but according to Mound & Halsey (1978) also a possible host for *D. citri*. This whitefly is probable native of the Oriental Region (Martin *et al.*, 2000) and it is a very important pest on all *Citrus* species throughout the citrus growing areas in Croatia (Žanić *et al.*, 2000). Species *A. elevatus* is according to Šimala (2008) already well established in the nature in coastal part of Croatia on figs (*Ficus carica* L.). The woolly whitefly, *A. floccosus* is present in Croatia from recently, only on limited area in central part of Dalmatia (Žanić *et al.*, 2007; Šimala, 2008). Although only known as a pest of citrus crops in the Mediterranean Basin, it is a polyphagous species recorded on 18 plant families (Mound & Halsey, 1978). Species *A. hikosanensis*, *A. jasmini* and *M. chittendeni* are newly recorded species for Croatia (Šimala, 2008). These are non European whitefly species. According to the recent check list of the world's whiteflies (Martin & Mound, 2007) the genus *Aleuroclava* Singh 1931 is comprehensive of 122 species. The only species recorded in Europe is *A. similis* Takahashi, 1938 (Martin *et al.*, 2000). *A. hikosanensis* is Eastern Palearctic species. It is distributed in Japan and Korea. This species feeds on plants belonging to eight families: Agnifoliaceae, Buxaceae, Ericaceae, Lauraceae, Myricaceae, Pittosporaceae, Styracaceae and Theaceae (Evans, 2006). *A. hikosanensis* was detected on imported macro bonsai plants of *Ilex crenata* Thunb. from Japan in the nurseries in Lučko and Turanj (Table 1). *A. jasmini* is according to Evans (2006) distributed in Hawaii, Pacific Islands, Eastern Palearctic, Oriental and Australasian zoographical region. This species develops on plants belonging to Myrsinaceae, Rhamnaceae, Rubiaceae and Rutaceae. In Croatia, it was intercepted in 2007 on *G. jasminoides* imported from The Netherlands (Table 2). *M. chittendeni* is probably native to

northern Asia, from where many rhododendrons which are the only host plants of this whitefly species, also originate (Martin *et al.*, 2000). Whereas, it has spread with the plant trade and is now distributed in Nearctic and Western Palearctic region, including some European countries (Evans, 2006). *M. chittendeni* was intercepted several times (Figure 2) on imported rhododendron plants from The Netherlands and Italy in 2005, 2007 and 2008 (Table 2).

4 CONCLUSIONS

Inspections of imported ornamental plants on presence of whiteflies carried out in Croatia from 2005-2008 have resulted in 9 recorded species. *Aleurothrixus floccosus*, *Aleyrodes elevatus*, *Bemisia afer*, *Bemisia tabaci*, *Dialeurodes citri* and *Trialeurodes vaporariorum* are indigenous or after incidentally introduction already established whitefly species in Croatia. Some of them are widespread throughout the country and some are distributed only on limited area. *Aleuroclava hikosanensis*, *Aleuroclava jasmini* and *Massilieuodes chittendeni* are non European species recorded for the first time in Croatia. They are new alien species and their possibility of naturalization in Croatia is not known. For this reason, a Pest Risk Analysis for these potentially pests is strongly suggested.

5 ACKNOWLEDGEMENTS

Thanks are due to M.G.M. Jansen from the Plant Protection Service, Wageningen, The Netherlands, for his generous help in education on whitefly identification and for confirmation of our identifications.

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