

Alate Aphid (Hemiptera: Aphididae) Species Composition and Richness in Northeastern USA Snap Beans and an Update To Historical Lists

Authors: Bachmann, Amanda C., Nault, Brian A., and Fleischer, Shelby J.

Source: Florida Entomologist, 97(3) : 979-994

Published By: Florida Entomological Society

URL: <https://doi.org/10.1653/024.097.0356>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

ALATE APHID (HEMIPTERA: APHIDIDAE) SPECIES COMPOSITION AND RICHNESS IN NORTHEASTERN USA SNAP BEANS AND AN UPDATE TO HISTORICAL LISTS

AMANDA C. BACHMANN¹, BRIAN A. NAULT² AND SHELBY J. FLEISCHER^{3,*}

¹South Dakota State University Department of Plant Science, 412 W Missouri Ave, Pierre, SD 57501, USA

²Cornell University Department of Entomology, New York State Agricultural Experiment Station, 630 W. North Street, Geneva, NY 14456, USA

³Penn State Department of Entomology, 501 ASI, University Park, PA 16802, USA

*Corresponding author; E-mail: shelly.fleischer@gmail.com

ABSTRACT

Recent aphid-vectored viruses in the northeastern U.S. led to extensive surveys of aphid (Hemiptera: Aphididae) species composition. We report the species composition and richness of alate aphids associated with processing snap bean (*Phaseolus vulgaris* L.; Fabales: Fabaceae) agroecosystems from field surveys conducted during 5 yr in New York and 3 yr in Pennsylvania. Rates of species accumulation were similar between the 2 states, and asymptotic, suggesting reasonably adequate sampling intensity. Our results suggest that about 95 to 100 aphid species are present as alates within these agroecosystems, a surprisingly high percentage (~14 to 18%) of the total aphid richness. Host records suggest that 61% of the alate aphid species we collected from pan traps placed within snap bean fields were dispersing through this agroecosystem, originating from woody plants in the surrounding landscape. We compiled this information with a recent study of aphid species composition from peach orchards and an exhaustive inspection of museum samples, and present an updated list of the aphid species in Pennsylvania.

Key Words: *Aphis glycines*, host, pan traps, peach, *Phaseolus vulgaris*, virus-vectors

RESUMEN

Los virus recién transmitidos por áfidos (pulgones) en el noreste de los EE.UU. resultó en un sondeo amplio de la composición de las especies de los áfidos (Hemiptera: Aphididae). Se reporta la composición y riqueza de especies de áfidos alados asociados con el agroecosistema de la habichuela procesada (*Phaseolus vulgaris* L.; Fabales : Fabaceae) de estudios de campo realizados durante 5 años en Nueva York y durante 3 años en Pennsylvania. La tasa de acumulación de especies fue similar entre los 2 estados y asintótica, lo que sugiere la intensidad del muestreo fue razonablemente adecuada. Nuestros resultados sugieren que aproximadamente 95 a 100 especies de áfidos están presentes como alados dentro de estos agroecosistemas, un porcentaje sorprendentemente alto (~14 a 18 %) de la riqueza total de los áfidos. Los registros de los hospederos sugieren que el 61 % de las especies de áfidos alados que recogimos en las trampas de caída colocadas dentro de los campos de habichuela se dispersaba a través de este agroecosistema, procedentes de plantas leñosas en el área alrededor. Hemos recopilado esta información con un reciente estudio sobre la composición de especies de áfidos en los huertos de durazno y una inspección exhaustiva de especímenes depositados en museos. Se incluye una lista actualizada de las especies de áfidos en Pennsylvania.

Palabras Clave: *Aphis glycines*, hospedero, trampas de caída, durazno, melocotón, *Phaseolus vulgaris*, vectores de virus

Aphids are a small, but diverse group of insects with an origin in the Jurassic and a total of 4800 species world-wide (Grimaldi & Engel 2005; Dixon 1985a; Dixon 1985b). They are

primarily phloem feeders and when present in high densities can damage their host plant. Aphids excrete excess carbohydrates from their diet of phloem sap, providing a nutrient-rich

substrate for sooty mold fungi to grow. Sooty mold can be a major problem in a number of agricultural crops because the mold can either render produce unmarketable or reduce plant quality of the commodity. Aphids are also important vectors of viruses that can kill their host plant or substantially reduce crop yield and quality (Agrios 2005). Some viruses are transmitted by aphids in a non-persistent, stylet-borne manner. They are obtained quickly by their aphid vector during short tasting probes, adhere to the stylet lining by binding to helper component proteins or directly to the stylet, and remain there until they are flushed out during another tasting probe (Ng & Falk 2006). Non-persistently transmitted viruses can be vectored by alates, sometimes by multiple aphid species (Gildow et al. 2008) regardless of whether or not there is reproduction on the plant host, and the epidemiology of these viruses can be influenced heavily by the alate aphid community.

Several viruses of this type have been introduced recently, or increased in frequency, in the northeastern U.S. One, *plum pox virus* (PPV), threatened the stone fruit industry following its arrival in the U.S. This virus causes sharka disease in parts of Europe and South America where it is endemic (Roy and Smith 1984; Rosales et al. 1998). Type D isolates were detected in the U.S. in Pennsylvania in 1999 (Damsteegt et al. 2001), and surveillance and eradication efforts of this invasive species included destruction of approximately 23% of the non-cherry stone fruit orchards of Pennsylvania (Wallis et al. 2005). As part of these efforts, studies were conducted to determine the potential aphid species that might serve as reservoir or route of transmission in the region where this virus was first detected (Wallis et al. 2005). Soon thereafter, in the early 2000s, Northeastern and Midwestern U.S., snap bean crops (*Phaseolus vulgaris* L; Fabales: Fabaceae.) had virus-like symptoms (leaf mosaic and blistering, deformed pods) and experienced dramatic yield loss (Larsen et al. 2002). Among the viruses detected were *alfalfa mosaic virus*, *bean common mosaic virus*, *bean pod mottle virus*, *bean yellow mosaic virus*, *clover yellow mosaic virus*, *clover yellow vein virus* (CIYVV), *cucumber mosaic virus* (CMV), *tobacco streak virus* and *white clover mosaic virus* (Grau et al. 2002; Larsen et al. 2002; Shah et al. 2006). CMV was the most prevalent virus detected in these snap bean fields (Larsen et al. 2002; Shah et al. 2006). As is the case with PPV, CMV is transmitted by aphids in a non-persistent, stylet-borne manner (Nault 1997). CMV-infected plants were often found in clumps in snap bean fields, which were consistent with aphid-initiated virus epidemics (Shah et al. 2005). CMV epidemics also occurred more frequently in New York than in Pennsyl-

vania. The CMV epidemics coincided with the appearance of a newly invasive aphid, *Aphis glycines* Matusmura (Nault et al. 2009), and as was the case with stone fruit, the threat of viral epidemics led to extensive surveys of the alate aphids species composition in the affected crop.

These recent surveys of aphid collected from snap bean fields in Pennsylvania and New York, and peach orchards in Pennsylvania, were quite extensive. Also from Pennsylvania, J. O. Pepper specialized in aphid identification and actively collected them for most of the 20th century. His collections centered at his home in central Pennsylvania (State College) and included much of the surrounding forest and farmland. The bulk of his collection is housed in the Frost Entomological Museum (University Park, Pennsylvania), and he also contributed slides to the United States National Collection (Beltsville, Maryland). Pepper (1965) reported 345 species in a published list of the aphids of Pennsylvania and their host plants. To date, this is the most comprehensive published list of aphids for the state. However, since taxonomy and systematics are in flux, the names that Pepper published are currently out of date and in need of revision.

The purpose of this study was to identify the species composition and estimate aphid species richness in snap bean agroecosystems in the northeastern states from field surveys, and generate a current list of aphid species in this region using field survey data, literature, and an examination of the J. O. Pepper aphid collection.

MATERIALS AND METHODS

Detailed methods for alate aphid collection in snap bean fields in Pennsylvania and New York were published in Nault et al. (2009). To summarize, we used water pan traps baited with a green ceramic tile (Webb et al. 1994) and filled with a 20% propylene glycol solution in snap bean fields in both states from 2002 – 2006 in NY and 2004 – 2006 in PA. Traps were installed in a total of 56 fields in western NY (12 each yr, except for 2004 which had 8 fields) and 18 fields in Centre county PA (6 each yr). The traps in Centre County formed an approximately 40 mile transect in the southern portion of the county roughly following state routes 45 and 192. The traps were checked weekly for aphids from the early trifoliate stage (early to mid Jul) until field harvest. Collection methods in the peach (*Prunus persica* (L.) Stokes; Rosales: Rosaceae) orchard are documented in Wallis et al (2005), and also used the water pan traps baited with a green tile. Trapping occurred during 2 yr in 2 orchards in central Pennsylvania.

For both studies, aphids were removed from pan traps and then stored in 70% etha-

TABLE 3. NEW APHID RECORDS FROM PENNSYLVANIA REPORTED IN NAULT ET AL. (2009) AND/OR WALLIS ET AL. (2005), BUT NOT FOUND IN PEPPER (1965).

Species	Nault et al.	Wallis et al.
<i>Acyrtosiphon kondoi</i>	•	
<i>Aphis glycines</i>	•	
<i>Aphis lugentis</i>		•
<i>Aphis (Protaphis) middletonii</i>	•	•
<i>Aphis pulchella</i>		•
<i>Nearctaphis clydesmithi</i>		•
<i>Tetraneura nigriabdominalis</i>		•

nol (EtOH), then transferred to potassium hydroxide and heated for 1 h or until clear. Cleared aphids were rinsed for 10 min each in a sequence of 95% EtOH, absolute EtOH, and clove oil. Once rinsed, each aphid was placed on a drop of Canada balsam on a glass slide and positioned to expose diagnostic features before a coverslip was placed on top. Aphids collected in New York were identified by R. Eckel (RVWE

Consulting, Frenchtown, New Jersey), whereas those from Pennsylvania were identified by W. Sackett and A. Bachmann using keys by Smith et al. (1992) and Blackman & Eastop (2000). Voucher specimens are located at the New York State Agricultural Experiment Station in Geneva, New York, and the Department of Entomology, Pennsylvania State University, University Park, Pennsylvania.

Species rarefaction curves were calculated for the Pennsylvania and New York collections individually and for both states combined using EstimateS (Colwell 2005).

A complete list of aphids from Pennsylvania was compiled using the J. O. Pepper Aphid Slide Collection, which is housed at the Frost Entomological Museum (University Park, Pennsylvania), as well as species recorded in Pepper (1965). We searched the slide collection in addition to using Pepper (1965) because Pepper continued to collect aphids and make slides into the late 1980s, but did not publish any updates to his original 1965 paper. Because the collection and Pepper (1965) contained aphid species names from the early 20th century, we consulted 2 online aphid databases to ensure that the

TABLE 4. SPECIES IN SIX SUBFAMILIES OF THE FAMILY APHIDIDAE OCCURRING IN PENNSYLVANIA.

Subfamily	Tribe	Species
Anoeciinae		<i>Anoecia corni</i>
		<i>Anoecia cornicola</i>
		<i>Anoecia oenotherae</i>
		<i>Anoecia setariae</i> Gillette & Palmer
Hormaphidinae	Cerataphidini	<i>Cerataphis lataniae</i> (Boisduval)
	Hormaphidini	<i>Hamamelistes spinosus</i> Shimer
		<i>Hormaphis hamamelidis</i> Fitch
Mindarinae		<i>Mindarus abietinus</i> Koch
Phyllaphidinae		<i>Phyllaphis fagi</i> (L.)
		<i>Stegophylla quercicola</i> (Monell)
		<i>Stegophylla quercifoliae</i> (Gillette)
		<i>Stegophylla quercina</i> Quednau
Pterocommatinae		<i>Fullawaya terricola</i> (Hottes & Frison)
		<i>Plocamaphis flocculosa</i> Weed
		<i>Pterocomma bicolor</i>
		<i>Pterocomma medium</i> Baker
		<i>Pterocomma populifoliae</i> (Fitch)
		<i>Pterocomma smithiae</i>
Saltusaphidinae	Saltusaphidini	<i>Iziphya flabella</i> (Sanborn)
		<i>Iziphya vittata</i> Richards
		<i>Strenaphis elongate</i> (Baker)
	Thripsaphidini	<i>Allaphis verrucosa</i> (Gillette)
		<i>Subsaltusaphis virginica</i> (Baker)
		<i>Thripsaphis ballii</i> (Gillette)

TABLE 5. SPECIES IN THE SUBFAMILY APHIDINAE, TRIBE MACROSIPHINI OCCURRING IN PENNSYLVANIA.

<i>Abstrusomyzus phloxae</i> (Sampson)	<i>Decorosiphon corynothrix</i> Börner	<i>Macrosiphum adiantii</i> (Oestlund)
<i>Acuticauda solidaginifoliae</i> (Williams)	<i>Diuraphis (Holcaphis) holci</i> (Hille Ris Lambers) Dysa-	<i>Macrosiphum californicum</i> (Clarke)
<i>Acyrtosiphon kondoi</i>	<i>phis (Pompaphis) plantaginea</i>	<i>Macrosiphum (Neocorylobium) carpinicolens</i> Patch
<i>Acyrtosiphon lactucae</i> (Passerini)	<i>Dysaphis tulipae</i>	<i>Macrosiphum (Neocorylobium) coryli</i> Davis
<i>Acyrtosiphon malvae</i> (Mosley)	<i>Ericaphis scammelli</i> (Mason)	<i>Macrosiphum cystopteris</i> Robinson
<i>Acyrtosiphon pisum</i>	<i>Ericaphis wakibae</i> (Hottes)	<i>Macrosiphum euphorbiae</i>
<i>Acyrtosiphon pseudodirhodum</i> (Patch)	<i>Hayhurstia atriplicis</i>	<i>Macrosiphum gaurae</i> (Williams)
<i>Amphorophora agathonica</i> Hottes	<i>Hyadaphis foeniculi</i>	<i>Macrosiphum gei</i> (Koch)
<i>Amphorophora ampullata</i> Buckton	<i>Hyalomyzus collinariae</i> (Pepper)	<i>Macrosiphum geranii</i> (Oestlund)
<i>Amphorophora rossi</i> Hottes & Frison	<i>Hyalomyzus eriobotryae</i> (Tissot)	<i>Macrosiphum lilii</i> (Monell)
<i>Amphorophora rubi</i>	<i>Hyalomyzus mitchellensis</i> Smith	<i>Macrosiphum pallidum</i> (Oestlund)
<i>Amphorophora sensoriata</i> Mason	<i>Hyalomyzus sensoriatius</i> (Mason)	<i>Macrosiphum (Neocorylobium) pseudocoryli</i>
<i>Aulacorthum solani</i>	<i>Hyalopteroides humilis</i> (Walker)	<i>Macrosiphum ptericolens</i> Patch
<i>Brachycaudus (Prunaphis) cardui</i> (L.)	<i>Hyperomyzus lactucae</i>	<i>Macrosiphum rosae</i>
<i>Brachycaudus helichrysi</i> (Kaltenbach)	<i>Hyperomyzus (Neonasonovia) nabali</i> (Oestlund)	<i>Macrosiphum tiliae</i> (Monell)
<i>Brachycaudus (Scrophulaphis)persicae</i> group	<i>Hyperomyzus (Neonasonovia) picridis</i> (Börner & Blunck)	<i>Mastopoda pteridis</i> Oestlund
<i>Brachycaudus (Brachycaudina) rociadae</i> (Cockerell)	<i>Idiopterus nephrolepidis</i> Davis	<i>Metopolophium dirhodum</i> (Walker)
<i>Brachycaudus (Thuleaphis) rumexicolens</i> (Patch)	<i>Illinoia azalea</i> (Mason)	<i>Microlophium sibiricum</i> (Mordvilko)
<i>Brachycaudus (Appelia) schwartzi</i> (Börner)	<i>Illinoia borealis</i> (Mason)	<i>Microsparsus desmodiorum</i> Smith & Tuatay
<i>Brachycorynella asparagi</i> (Mordvilko)	<i>Illinoia canadensis</i> (MacGillivray)	<i>Microparsus singularis</i> (Hottes & Frison)
<i>Brevicoryne brassicae</i>	<i>Illinoia goldmaryae</i> (Knowlton)	<i>Muscaphis music</i> Börner
<i>Cachryphora canadensis</i> Hille Ris Lambers	<i>Illinoia liriodendri</i>	<i>Myzaphis rosarum</i> (Kaltenbach)
<i>Cachryphora serotinae</i> (Oestlund)	<i>Illinoia pepperi</i> (MacGillivray)	<i>Myzodium modestum</i> (Hottes)
<i>Capitophorus carduinus</i> (Walker)	<i>Illinoia (Masonaphis) rhokalaza</i> (Tissot & Pepper)	<i>Myzus cerasi</i> (Fabricius)
<i>Capitophorus elaeagni</i>	<i>Illinoia richardsi</i> (MacGillivray)	<i>Myzus formosanus</i> Takahashi
<i>Capitophorus hippophaes</i>	<i>Illinoia (Oestlundia) rubicola</i> (Oestlund)	<i>Myzus lythri</i> (Schränk)
<i>Carolinaia caricis</i> Wilson	<i>Illinoia spiraeicola</i> (Patch)	<i>Myzus ornatus</i> Liang
<i>Carolinaia (Galbromyzus) howardii</i> (Wilson)	<i>Linosiphon sanguinarium</i> (Hottes & Frison)	<i>Myzus (Nectarosiphon) persicae</i>
<i>Carolinaia (Glabromyzus) rhois</i>	<i>Liosomaphis berberidis</i> (Kaltenbach)	<i>Nasonovia (Kakima) aquilegiae</i> (Essig)
<i>Catamerus Kickapoo</i> (Hottes & Frison)	<i>Lipaphis pseudobrassicae</i>	<i>Nasonovia compositellae</i> (Theobald)
<i>Caviarella aegopodii</i> (Scopoli)	<i>Longicaudus trirhodus</i> (Walker)	<i>Nasonovia (Kakima) cynosbati</i> (Oestlund)
<i>Caviarella cicutae</i> (Koch)	<i>Macrosiphoniella abrotani</i> (Walker)	<i>Nasonovia (Kakima) heucherae</i> (Thomas)
<i>Caviarella hendersoni</i> Knowlton & Smith	<i>Macrosiphoniella frigidicola</i> Gillette & Palmer	<i>Nasonovia (Ranakimia) purpurascens</i> (Oestlund)
<i>Caviarella pastinacae</i> (L.)	<i>Macrosiphoniella leucanthemi</i> (Ferrari)	<i>Nasonovia ribisnigri</i> (Mosley)
<i>Caviarella salicis</i> (Monell)	<i>Macrosiphoniella ludoviciana</i>	<i>Nearctaphis bakeri</i>
<i>Caviarella theobaldi</i> (Gillette & Bragg)	<i>Macrosiphoniella millefolii</i> (De Geer)	<i>Nearctaphis clydesmithi</i>
<i>Ceruraphis eriophori</i> (Walker)	<i>Macrosiphoniella (Phalangomyzus) pennsylvanica</i> (Pepper)	<i>Nearctaphis crataegifoliae</i>
<i>Ceruraphis viburnicola</i> (Gillette)	<i>Macrosiphoniella sanborni</i>	<i>Neomyzus circumflexus</i> (Buckton)
<i>Chaetosiphon (Pentatrichopus) fragaefolii</i> (Cockerell)	<i>Macrosiphoniella subterranean</i> (Koch)	<i>Neotoxoptera formosana</i> (Takahashi)
<i>Chaetosiphon (Pentatrichopus) minor</i> (Forbes)	<i>Macrosiphoniella tanacetaria</i> (Kaltenbach)	<i>Neotoxoptera violae</i> (Pergande)
<i>Chaetosiphon (Pentatrichopus) tettrarhodum</i> (Walker)	<i>Macrosiphoniella tapuskae</i> (Hottes & Frison)	<i>Ovatus crataegarius</i>
<i>Coloradoa rufomaculata</i> (Wilson)		
<i>Cryptomyzus ribis</i> (L.)		

TABLE 5. (CONTINUED) SPECIES IN THE SUBFAMILY APHIDINAE, TRIBE MACROSIPHINI OCCURRING IN PENNSYLVANIA.

<i>Papulaphis sleesmani</i> (Pepper)	<i>Uroleucon ambrosiae</i> (Thomas)	<i>Uroleucon nigrotibium</i> (Olive)
<i>Phorodon humuli</i>	<i>Uroleucon anomala</i>	<i>Uroleucon nigrotuberculatum</i> (Olive)
<i>Plectrichophorus ambrosiae</i> Hille Ris Lambers	<i>Uroleucon (Lambersius) caligatum</i> (Richards)	<i>Uroleucon obscuricaudatum</i> (Olive)
<i>Plectrichophorus asterifoliae</i> (Strom)	<i>Uroleucon chrysanthemi</i> (Oestlund)	<i>Uroleucon paucensortiatum</i> (Hille Ris Lambers)
<i>Plectrichophorus glandulosus</i> (Kaltenbach)	<i>Uroleucon chrysopsidicola</i> (Olive)	<i>Uroleucon pepperi</i> (Olive)
<i>Plectrichophorus patonkusi</i> (Hottes & Frison)	<i>Uroleucon (Lambersius) erigeronense</i> (Thomas)	<i>Uroleucon pieloui</i> (Richards)
<i>Plectrichophorus wasatchii</i> (Knowlton)	<i>Uroleucon eupatoricolens</i> (Patch)	<i>Uroleucon pseudambrosiae</i>
<i>Pseudacaudella rubida</i> Börner	<i>Uroleucon (Uromelan) eupatorifoliae</i> (Tissot)	<i>Uroleucon rudbeckiae</i> (Fitch)
<i>Rhodobium porosum</i>	<i>Uroleucon floricola</i> Robinson	<i>Uroleucon (Uromelan) rurale</i> (Hottes & Frison)
<i>Rhopalosiphoninus latysiphon</i>	<i>Uroleucon (Lambersius) gravicorne</i> (Patch)	<i>Uroleucon russellae</i> (Hille Ris Lambers)
<i>Rhopalosiphoninus (Myzosphon) solani</i> (Thomas)	<i>Uroleucon (Uromelan) helianthicola</i> (Olive)	<i>Uroleucon sonchellum</i> (Monell)
<i>Rhopalosiphoninus staphyleae</i> (Koch)	<i>Uroleucon (Uromelan) illini</i> (Hottes & Frison)	<i>Uroleucon sonchi</i> (L.)
<i>Rhopalomyzus (Judenkoa) loniceræ</i> (Stebold)	<i>Uroleucon impatiensicolens</i> (Patch)	<i>Uroleucon (Uromelan) taraxaci</i> (Kaltenbach)
<i>Rhopalomyzus poae</i> (Gillette)	<i>Uroleucon lanceolatum</i> (Patch)	<i>Uroleucon (Uromelan) tardae</i> (Hottes & Frison)
<i>Sitobion avenae</i>	<i>Uroleucon leonardi</i> (Olive)	<i>Uroleucon (Uromelan) tuataiae</i> Olive
	<i>Uroleucon (Lambersius) luteolum</i> (Williams)	<i>Utamphorophora crataegi</i>
		<i>Utamphorophora humboldti</i> (Essig)

final list used the most current nomenclature (Aphid Species File – <http://aphidspeciesfile.org>, accessed 22-IV-2012 and Aphids on the World’s Plants - <http://www.aphidsonworldsplants.info/>, accessed 1-XI-2013). We combined our findings from the Pepper collection material with the results of our pan trapping study and Wallis et al. (2005) to create a more current list of the aphids of Pennsylvania (Tables 3–11).

RESULTS

In snap bean fields in New York and Pennsylvania, a total of 8,821 aphids were identified, with 7,484 from New York and 1,337 from Pennsylvania. A total of 97 species were caught; 71 from New York and 41 from Pennsylvania. We were unable to identify only 254 (2.8%) of the aphids. Of the aphids captured, those species representing 1% or greater of the total number caught in either state are listed in Table 1 (originally published in Nault et al. 2009) with their abundances. A comprehensive list of all aphid species found in Pennsylvania and New York snap bean fields is shown in Table 2 along with their host associations based on Blackman & Eastop (1994, 2000, and 2006). From this host information we estimated that 61 percent of the species dispersing through snap bean fields in both states were most likely coming in from the surrounding forests as their hosts are woody, not herbaceous, species (Fig. 1).

Species accumulations followed asymptotic patterns (Fig. 2) suggesting reasonably adequate sampling of the aphid species present as alates in commercial snap bean fields. Overall, there were fewer aphids collected in Pennsylvania, but based on the rarefaction curve there were a similar number of total species represented in a sample of the same number of in-

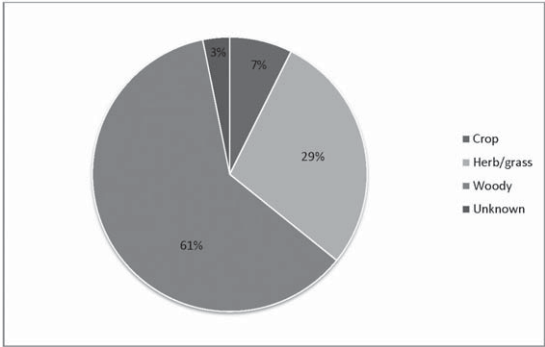


Fig. 1. Proportion of aphids from the pan trapping collection in Pennsylvania and New York that use herbaceous plants, trees, or crops as primary hosts. Host associations for North America characterized from Blackman & Eastop (1994, 2000, 2006).

TABLE 6. SPECIES IN THE SUBFAMILY APHIDINAE, TRIBE APHIDINI OCCURRING IN PENNSYLVANIA.

<i>Aphis angelicae</i> Lee & Seo	<i>Aphis (Protaphis) knowltoni</i> Hottes & Frison	<i>Hyalopterus pruni</i>
<i>Aphis asclepiadis</i> Fitch	<i>Aphis lugentis</i>	<i>Hysteroneura setariae</i>
<i>Aphis caliginosa</i> Hottes & Frison	<i>Aphis maculatae</i> Oestlund	
<i>Aphis carduella</i>	<i>Aphis (Protaphis) middletonii</i>	<i>Pseudasiphonaphis corni</i> (Tissot)
<i>Aphis cephalanthi</i>	<i>Aphis nasturtii</i>	
<i>Aphis coreopsidis</i> (Thomas)	<i>Aphis neilliae</i> Oestlund	<i>Rhopalosiphum cerasifoliae</i> (Fitch)
<i>Aphis cornifoliae</i> Fitch	<i>Aphis nerii</i> Boyer de Fonscolombe	<i>Rhopalosiphum enigma</i> Hottes & Frison
<i>Aphis craccivora</i>	<i>Aphis (Bursaphis) oenotherae</i> Oestlund	<i>Rhopalosiphum maidis</i>
<i>Aphis debilicornis</i> Gillette & Palmer	<i>Aphis oenotherae sanborni</i>	<i>Rhopalosiphum musae</i> (Schouteden)
<i>Aphis decepta</i> Hottes & Frison	<i>Aphis oestlundii</i>	<i>Rhopalosiphum nigrum</i> Richards
<i>Aphis fabae</i>	<i>Aphis pawneepae</i> Hottes	<i>Rhopalosiphum nymphaeae</i>
<i>Aphis farinosa</i> Gmelin	<i>Aphis pomi</i>	<i>Rhopalosiphum oxycanthae</i>
<i>Aphis feminea</i> Hottes	<i>Aphis pulchella</i>	<i>Rhopalosiphum padi</i>
<i>Aphis folsomii</i> Davis	<i>Aphis rubicola</i> Oestlund	<i>Rhopalosiphum parvae</i> Hottes & Frison
<i>Aphis forbesi</i> Weed	<i>Aphis rubifolii</i>	<i>Rhopalosiphum rufiabdominale</i>
<i>Aphis frangulae</i> Kaltenbach	<i>Aphis rumicis</i>	<i>Rhopalosiphum sanguinarium</i> McVicar Baker
<i>Aphis gerardiae</i> (Thomas)	<i>Aphis sambuci</i> (L.)	
<i>Aphis glycines</i>	<i>Aphis spiraeicola</i>	<i>Sanbornia juniper</i> Pergande ex Baker
<i>Aphis gossypii</i>	<i>Aphis spiraeophila</i> Patch	<i>Schizaphis graminum</i>
<i>Aphis hamamelidis</i> Pepper	<i>Aphis (Bursaphis) varians</i> Patch	<i>Schizaphis nigra</i> (Baker)
<i>Aphis hederac</i>	<i>Aphis vernoniae</i> Thomas	
<i>Aphis illinoisensis</i> Shimer	<i>Aphis viturniphila</i>	
<i>Aphis impatientis</i> Thomas		

TABLE 7. SPECIES IN THE SUBFAMILY CALAPHIDINAE OCCURRING IN PENNSYLVANIA.

Tribe	Species			
Calaphidini	<i>Betulaphis quadrituberculata</i> (Kaltenbach)	Calaphis (<i>Cepigillettea</i>) <i>myricae</i> (Patch)	<i>Euceraphis mucida</i> (Fitch)	
	<i>Calaphisalni</i> Baker	<i>Callipterinella calliptera</i> (Hartig)	<i>Euceraphis punctipennis</i> (Zetterstedt)	
	<i>Calaphis betulacolens</i> (Fitch)	<i>Euceraphis betulae</i> Koch	<i>Hannabura alnosa</i> (Pepper)	
	<i>Calaphis betulella</i> Walsh	<i>Euceraphis gillettei</i> Davidson		
	<i>Calaphis leonardi</i> Quednau	<i>Euceraphis lineata</i> Baker		
Panaphidini	<i>Chromaphis juglandicola</i> (Kaltenbach)	<i>Myzocallis (Lineomyzocallis) bella</i> (Walsh)	<i>Myzocallis (Lineomyzocallis) walskii</i> (Monell)	
	<i>Eucallipterus tiliac</i> (L.)	<i>Myzocallis (Castaneomyzocallis) castaneae</i> (Fitch)	<i>Neosymydobius albasiphus</i> (Davis)	
	<i>Hoplochaitophorus heterotrichus</i> Quednau	<i>Myzocallis (Agrioaphis) castanicola</i> Baker	<i>Patchia virginiana</i> Baker	
	<i>Hoplochaitophorus quercicola</i> (Monell)	<i>Myzocallis coryli</i> (Goetze)	<i>Protopterocallis fumipennella</i> (Fitch)	
	<i>Lachnochaitophorus obscurus</i> (Tissot)	<i>Myzocallis (Neomyzocallis) discolor</i> (Monell)	<i>Protopterocallis gigantea</i> Bissell	
	<i>Melanocallis caryaefoliae</i> (Davis)	<i>Myzocallis (Lineomyzocallis) exultans</i> Boudreaux & Tissot	<i>Protopterocallis pergandei</i> Bissell	
	<i>Monellia caryella</i>	<i>Myzocallis (Lineomyzocallis) frisoni</i> Boudreaux & Tissot	<i>Pterocallis alnifoliae</i> (Fitch)	
	<i>Monellia hispida</i> Quednau	<i>Myzocallis (Lineomyzocallis) granovskyi</i> Boudreaux & Tissot	<i>Therioaphis ononidis</i> (Kaltenbach)	
	<i>Monellia microsetosa</i> Richards	<i>Myzocallis (Lineomyzocallis) longiunguis</i> Boudreaux & Tissot	<i>Therioaphis riehmii</i>	
	<i>Monelliopsis bisselli</i> Quednau	<i>Myzocallis (Lineomyzocallis) melanocera</i> Boudreaux & Tissot	<i>Therioaphis trifolii</i>	
	<i>Monelliopsis caryae</i> (Monell)	<i>Myzocallis (Lineomyzocallis) multisetis</i> Boudreaux & Tissot	<i>Therioaphis trifolii forma maculata</i> (Buckton)	
	<i>Monelliopsis nigropunctata</i> (Granovsky)	<i>Myzocallis (Neomyzocallis) punctata</i> (Monell)	<i>Tinocallis ulmifolii</i> (Monell)	
	<i>Myzocallis alhambra</i> Davidson	<i>Myzocallis (Lineomyzocallis) spinosa</i> Boudreaux & Tissot	<i>Tuberculatus punctatella</i> Fitch	
	<i>Myzocallis (Neomyzocallis) asclepiadis</i> (Monell)	<i>Myzocallis (Neomyzocallis) tuberculata</i> Richards		

TABLE 8. SPECIES IN THE SUBFAMILY CHAITOPHORINAE OCCURRING IN PENNSYLVANIA.

Tribe	Species	
Chaitophorini	<i>Chaitophorus longipes</i> Tissot	<i>Chaitophorus populifolii</i>
	<i>Chaitophorus nigrae</i> Oestlund	<i>Chaitophorus pusillus</i> Hottes & Frison
	<i>Chaitophorus nigricentrus</i> Richards	<i>Chaitophorus saliniger</i> Shinji
	<i>Chaitophorus nudus</i> Richards	<i>Chaitophorus stevensi</i> Sanborn
	<i>Chaitophorus populicola</i> Thomas	<i>Chaitophorus viminalis</i> Monell
	<i>Chaitophorus populifoliae</i> Oestlund	
Siphini	<i>Sipha (Rungtia) elegans</i> del Guerciò	<i>Sipha flava</i>
		<i>Sipha glyceriae</i>
		<i>Chaitophorus viminicola</i> Hille Ris Lambers
		<i>Periphyllus americanus</i>
		<i>Periphyllus californiensis</i> (Shinji)
		<i>Periphyllus lyropictus</i> (Kessler)
		<i>Periphyllus negundinis</i> (Thomas)

dividuals (Figs. 2 and 3, at 1,250 individuals there would be 45 species sampled in Pennsylvania and 50 in New York). Based on the historical collections reported by Pepper, there are approximately 350 aphid species in Pennsylvania. Historical reports in Leonard (1963) suggest that there are approximately 430 aphid species in New York.

Combining the list of aphids collected from snap bean fields, peach orchards and those published by J. O. Pepper in 1965, we developed a new, more comprehensive list of the aphids present in Pennsylvania. We found 7 species present in our collections that were not present in the slide collection housed in the Frost Entomological Museum (University Park, Pennsylvania) or published in Pepper (1965) (Table 3). One of these aphids, *Aphis glycines* Matsumura, was introduced to the US around the turn of the 21st century and is now widespread throughout the Midwest, Northeast and southeastern Canada (Ragsdale et al. 2011).

DISCUSSION

Our passive trapping in snap bean fields alone yielded a surprisingly high percentage of the species present throughout Pennsylvania and New York (~14% and ~18% respectively). Our sampling method concentrated on only one habitat (commercial snap bean fields), but did intercept aphids moving from the surrounding forests and hedgerows. The high degree of landscape heterogeneity and crop diversity in the trapping areas includes plant species that serve as hosts for many of the aphid species that represented less than 1% of the total capture (Pfleege et al. 2006). These aphids were captured in very small numbers (mostly singletons), and are not important contributors to the plant virus epidemics reported by Wallis et al. (2005) and Nault et al. (2009).

Of the aphids we captured, 2 species were especially notable; *Therioaphis trifolii* Monell, which comprised 31.8% of the identified aphids, and *A. glycines* which represented 18.2 % of the identified aphids. Both of these aphids were

TABLE 9. SPECIES IN THE SUBFAMILY DREPANOSIPHINAE OCCURRING IN PENNSYLVANIA.

<i>Drepanaphis acerifoliae</i>	<i>Drepanaphis nigricans</i>	<i>Drepanaphis spicata</i> Smith
<i>Drepanaphis carolinensis</i>	<i>Drepanaphis parva</i> Smith	<i>Drepanosiphum platanoidis</i>
<i>Drepanaphis kanzensis</i> Smith	<i>Drepanaphis sabrinae</i> Miller	<i>Shenahweum minutum</i> (Davis)
<i>Drepanaphis monelli</i> Davis	<i>Drepanaphis simpsoni</i> Smith	

TABLE 10. SPECIES IN THE SUBFAMILY ERIOSOMATINAE OCCURRING IN PENNSYLVANIA.

Tribe	Species	
Eriosomatini	<i>Eriosoma lanigerum</i>	<i>Eriosoma wilsoni</i> Remaudière
	<i>Colopha graminis</i> (Monell)	<i>Kaltenbachella ulmifusa</i> (Walsh & Riley)
	<i>Colopha ulmicola</i> (Fitch)	<i>Tetraneura nigriabdominalis</i>
	<i>Eriosoma americanum</i> (Riley)	<i>Tetraneura ulmi</i> (L.)
Fordini	<i>Eriosoma crataegi</i> (Oestlund)	
	<i>Forda marginata</i> Koch	
	<i>Geocia ultriculata</i> group	
Pemphigini	<i>Grylloprociphilus imbricator</i> (Fitch)	<i>Prociphilus longianus</i> Smith
	<i>Mordwilkoja vagabunda</i> (Walsh)	<i>Prociphilus (Pultivius) probosceus</i> (Sanborn)
	<i>Neoprociphilus aceris</i> (Monell)	<i>Prociphilus (Paraprociphilus) tessellatus</i> (Fitch)
	<i>Pachypappa pseudobyrsa</i> (Walsh)	<i>Thecabius affinis</i> (Kaltenbach)
	<i>Pemphigus bursarius</i> (L.)	<i>Thecabius (Parathecabius) graivicornis</i> (Patch)
	<i>Pemphigus monophagus</i> Maxson	<i>Thecabius populimonilis</i> (Riley)
	<i>Pemphigus nortonii</i> Maxson	
	<i>Pemphigus populecaulis</i>	

TABLE 11. SPECIES IN THE SUBFAMILY LACHNINAE OCCURRING IN PENNSYLVANIA.

Tribe	Species	
Eulachnini	<i>Cinara atlantica</i>	<i>Cinara taedae</i> Tissot
	<i>Cinara banksiana</i> Pepper & Tissot	<i>Cinara (Cupressobium) tujafilina</i> (Del Guercio)
	<i>Cinara braggii</i> (Gillette)	<i>Cinara watsoni</i> Tissot
	<i>Cinara canatra</i> Hottes & Bradley	<i>Essigella pini</i>
	<i>Cinara costata</i> (Zetterstedt)	<i>Eulachnus agilis</i> (Kaltenbach)
	<i>Cinara (Cupressobium) cupressi</i> (Buckton)	<i>Eulachnus americanus</i> Takahashi
	<i>Cinara fornicula</i> Hottes	<i>Eulachnus rileyi</i>
	<i>Cinara gracilis</i> (Wilson)	<i>Schizolachnus parvus</i> (Wilson)
	<i>Cinara harmonia</i> Hottes	<i>Schizolachnus piniradiatae</i> (Davidson)
	<i>Cinara juniperi</i> De Geer	
Lachnini	<i>Lachnus allegheniensis</i> McCook	
	<i>Longistigma caryae</i> (Harris)	
Tramini	<i>Trama rara</i> Mordvilko	

TABLE 1. ALATE APHID SPECIES REPRESENTING > 1 % OF THE CAPTURE FROM WATER PAN TRAPS IN COMMERCIAL SNAP BEAN FIELDS IN PENNSYLVANIA (2004–2006) AND NEW YORK (2002–2006). DERIVED FROM TABLE 1 IN NAULT ET AL. (2009).

Species	New York			Pennsylvania			Overall		
	Total	Percent of Total	Total	Total	Percent of Total	Total	Total	Percent of Total	Total
<i>Therioaphis trifolii</i> (Monell)	2,274	30.4		535	40.0	2809		31.8	
<i>Aphis glycines</i> Matsumura	1,475	19.7		131	9.8	1606		18.2	
<i>Acyrtosiphon pisum</i> (Harris)	1,106	14.8		28	2.1	1134		12.9	
<i>Rhopalosiphum maidis</i> (Fitch)	685	9.2		75	5.6	760		8.6	
<i>Penphigus populicaulis</i> Fitch	239	3.2		0	0.0	239		2.7	
<i>Aphis craccivora</i> Koch	179	2.4		123	9.2	302		3.4	
<i>Aphis gossypii</i> Glover	130	1.7		201	15.0	331		3.8	
<i>Hayhurstia atriplicis</i> (L.)	128	1.7		1	0.1	129		1.5	
<i>Lipaphis pseudobrassicae</i> (Davis)*	128	1.7		0	0.0	128		1.5	
<i>Myzus persicae</i> (Sulzer)	97	1.3		26	1.9	123		1.4	
<i>Capitophorus eleagni</i> (Del Guerica)	79	1.1		7	0.5	86		1.0	
<i>Aphis</i> sp.	77	1.0		0	0.0	77		0.9	
<i>Rhopalosiphum padi</i> (L.)	77	1.0		45	3.4	122		1.4	
<i>Aphis fabae</i> Scopoli	15	0.2		14	1.0	29		0.3	
<i>Anoea</i> sp.	1	<0.1		14	1.0	15		0.2	
<i>Brachycaudus persicae</i> (Passerini)	2	<0.1		15	1.1	17		0.2	
Unknown	216	2.9		38	2.8	254		2.9	
Others	576	7.7		84	6.3	660		7.5	
Total	7,484	100.0		1,337	100.0	8,821		100.0	

*Published in Nault et al (2009) as *Lipaphis erysimi* (Kaltenbach).

TABLE 2. SPECIES OF ALATE APHIDS WITH HOST ASSOCIATIONS, COLLECTED FROM WATER PAN TRAPS IN COMMERCIAL SNAP BEAN FIELDS IN PENNSYLVANIA (2004–2006) AND NY (2002–2006), AND FROM SIMILAR TRAPS IN PEACH ORCHARDS IN CENTRAL PENNSYLVANIA (2003–2004, WALLIS ET AL. 2005). PRIMARY AND SECONDARY HOST PLANT ASSOCIATIONS FOR NORTH AMERICA TAKEN FROM BLACKMAN & EASTOP (1994 [AWT], 2000 [AWC], AND 2006 [HPS]).

Aphid Species	Crop Sampled				Primary Host for Aphid	Secondary Host for Aphid	Source
	Snap bean		Peach				
	PA	NY	PA				
<i>Acyrtosiphon kondoi</i> Shinji	•	•			Leguminosae, Trifoleae, Loteae		AWC
<i>Acyrtosiphon pisum</i> Harris	•	•	•		Leguminosae, Genistae, Trifoleae, Fabae, Hedysareae		AWC
<i>Amphorophora rubi</i> Kaltenbach	•	•			<i>Rubus</i> spp.		HPS
<i>Anoea corni</i> (Fabricius)	•	•	•		<i>Cornus sanguinea</i>	Gramineae	AWT
<i>Anoea cornicola</i> (Walsh)	•				<i>Cornus</i> spp.	Gramineae	AWT
<i>Anoea oenotherae</i> Wilson			•		<i>Cornus</i> spp.	<i>Oenothera biennis</i>	AWT
<i>Aphis carduella</i> Walsh	•	•			<i>Cornus stolonifera</i>	Umbelliferae	AWT
<i>Aphis cephalanthi</i> Thomas	•	•			<i>Cephalanthus occidentalis</i>		HPS
<i>Aphis craccivora</i> Koch	•	•			polyphagous, Leguminosae		AWC
<i>Aphis fabae</i> Scopoli	•	•	•		Euonymous europaeus, Viburnum opulus	polyphagous	AWC
<i>Aphis forbesi</i> Weed		•			<i>Fragaria</i> spp.		HPS
<i>Aphis glycines</i> Matsumura	•	•			<i>Rhamnus</i> spp.	<i>Glycine max</i>	AWC
<i>Aphis gossypii</i> Glover	•	•	•		<i>Catalpa, Hibiscus, Celastrus, Rhamnus, Punica</i>	polyphagous, cotton, cucurbits	all
<i>Aphis hederæ</i> Kaltenbach			•		<i>Hedera helix</i> , Araliaceae, <i>Cuscuta</i>		HPS
<i>Aphis lugentis</i> Williams			•		<i>Senecio</i> spp., <i>Erigeron</i> sp.		HPS
<i>Aphis (Protaphis) middletonii</i> Thomas	•	•	•		Compositae, Cruciferae, Umbelliferae, Grami- nae		AWC
<i>Aphis nasturtii</i> Kaltenbach			•		<i>Rhamnus cathartica, R. alnifolia</i>	wide range	HPS
<i>Aphis oestlundii</i> Gillette	•				<i>Oenothera biennis</i>		HPS
<i>Aphis pomi</i> DeGeer		•			Pyroidea		AWC
<i>Aphis pulchella</i> Hottes & Frison		•	•		Euphorbia		HPS
<i>Aphis rubifolii</i> (Thomas)		•			<i>Rubus</i> spp.		HPS
<i>Aphis rumicis</i> L.		•			<i>Rumex</i> spp., <i>Rheum</i> spp.		HPS
<i>Aphis spiraeola</i> Patch		•	•		Citrus, <i>Spiraea</i> spp., polyphagous		AWC
<i>Aphis viburniphila</i> Patch	•				<i>Viburnum</i> spp.		HPS
<i>Aulacorthum solani</i> (Kaltenbach)	•				Polyphagous		HPS
<i>Brachycaudus (Scrophulaphis) persicae</i> group		•	•		<i>Prunus persica, P. armeniaca</i>	Scrophulariaceae	AWT
<i>Brevicoryne brassicae</i> (L.)		•	•		Cruciferae		AWC
<i>Capitophorus elaeagni</i> (del Guercio)	•	•	•		<i>Elaeagnus</i> spp.	tubuliferous Compositae	AWT
<i>Capitophorus hippophaes</i> (Walker)	•	•	•		Elaeagnaceae	<i>Polygonum</i> spp., <i>Persicaria</i> spp.	AWT

TABLE 2. (CONTINUED) 1 SPECIES OF ALATE APHIDS WITH HOST ASSOCIATIONS, COLLECTED FROM WATER PAN TRAPS IN COMMERCIAL SNAP BEAN FIELDS IN PENNSYLVANIA (2004–2006) AND NY (2002–2006), AND FROM SIMILAR TRAPS IN PEACH ORCHARDS IN CENTRAL PENNSYLVANIA (2003–2004, WALLIS ET AL. 2005). PRIMARY AND SECONDARY HOST PLANT ASSOCIATIONS FOR NORTH AMERICA TAKEN FROM BLACKMAN & EASTOP (1994 [AWT], 2000 [AWC], AND 2006 [HPS]).

Aphid Species	Crop Sampled			Primary Host for Aphid	Secondary Host for Aphid	Source
	Snap bean		Peach			
	PA	NY	PA			
<i>Carolinaia (Glabromyzus) rhois</i> (Monell)			•	<i>Rhus glabra</i> , <i>R. typhina</i>	Gramineae	AWC
<i>Chaitophorus populifolii</i> Essig	•		•	<i>Populus</i> spp.		AWT
<i>Cinara atlantica</i> (Wilson)	•			<i>Pinus</i> spp.		AWT
<i>Drepanaphis acerifoliae</i> (Thomas)		•		<i>Acer saccharinum</i> , <i>A. rubrum</i> , <i>A. saccharum</i>		AWT
<i>Drepanaphis carolinensis</i> Smith		•		<i>Acer saccharum</i> , <i>A. rubrum</i>		AWT
<i>Drepanaphis nigricans</i> Smith		•		<i>Acer rubrum</i>		AWT
<i>Drepanaphis sabrinae</i> Miller			•	<i>Acer saccharum</i>		AWT
<i>Drepanosiphum platanoidis</i> (Schrank)		•		<i>Acer pseudoplatanus</i> , <i>Acer</i> spp., sycamore		AWT
<i>Dysaphis (Pomaphis) plantaginea</i> (Passerini)		•		<i>Malus</i> spp., <i>Pyrus</i>	<i>Plantago</i> spp.	AWT
<i>Dysaphis tulipae</i> (Boyer de Fonscolombe)			•	many monocots		AWC
<i>Eriosoma lanigerum</i> (Hausmann)			•	Pyroidea, apple, Crataegus, Coloneaster		AWC
<i>Essigella pini</i> (Wilson)	•			<i>Pinus</i> spp.		AWT
<i>Eulachnus rileyi</i> (Williams)		•	•	<i>Pinus</i> spp.		AWT
<i>Geoica squamosa</i> Hart		•				
<i>Hayhurstia atriplicis</i> (L.)	•			Chenopodiaceae, Atriplex, <i>Chenopodium</i> spp.		HPS
<i>Hyadaphis foeniculi</i> (Passerini)	•			<i>Lonicer</i> a spp.	<i>Umbelliferae</i> spp.	AWC
<i>Hyalopterus pruni</i> (Geoffroy)		•		<i>Prunus domestica</i> , <i>P. armeniaca</i>	<i>Phragmites communis</i> , <i>Arundo donax</i>	AWC
<i>Hyperomyzus lactucae</i> (L.)		•			<i>Sonchus</i> spp.	AWC
<i>Hysteroneura setariae</i> (Thomas)		•		<i>Prunus domestica</i>	Gramineae	AWC
<i>Illinoia liriodendri</i> (Monell)		•		<i>Liriodendron tulipifera</i>		AWT
<i>Kaltenbachella ulmifusa</i> (Walsh & Riley)			•	<i>Ulmus rubra</i>	Labiatae	AWT
<i>Lipaphis pseudobrassicae</i> (Davis)		•		Cruciferae		AWC
<i>Macrosiphoniella ludoviciana</i> (Oestlund)	•			<i>Artemisia ludoviciana</i> , <i>A. vulgaris</i>		HPS
<i>Macrosiphoniella sanborni</i> (Gillette)	•			<i>Dendranthema indicum</i> , <i>morifolium</i> , <i>frutescens</i> , Compositae		AWC
<i>Macrosiphum euphorbiae</i> (Thomas)	•	•	•	<i>Rosa</i> spp	highly polyphagous, Solanaceae	AWC
<i>Macrosiphum pallidum</i> (Oestlund)	•	•		Rosaceae, <i>Rosa</i> spp.		AWC

TABLE 2. (CONTINUED) 2 SPECIES OF ALATE APHIDS WITH HOST ASSOCIATIONS, COLLECTED FROM WATER PAN TRAPS IN COMMERCIAL SNAP BEAN FIELDS IN PENNSYLVANIA (2004–2006) AND NY (2002–2006), AND FROM SIMILAR TRAPS IN PEACH ORCHARDS IN CENTRAL PENNSYLVANIA (2003–2004, WALLIS ET AL. 2005). PRIMARY AND SECONDARY HOST PLANT ASSOCIATIONS FOR NORTH AMERICA TAKEN FROM BLACKMAN & EASTOP (1994 [AWT], 2000 [AWC], AND 2006 [HPS]).

Aphid Species	Crop Sampled				Primary Host for Aphid	Secondary Host for Aphid	Source
	Snap bean		Peach				
	PA	NY	PA				
<i>Macrosiphum (Neocorylobium) pseudocoryli</i> (Patch)		•			<i>Ostrya virginiana</i> , <i>Corylus</i> spp.		AWT
<i>Macrosiphum rosae</i> (L.)		•			<i>Rosa</i> spp.	Dipsacaceae	AWC
<i>Melanaphis rhois</i> (Fitch)	•				<i>Rhus</i> spp. (<i>glabra</i> , <i>typhina</i>)	mosses	AWT
<i>Monellia caryella</i> (Fitch)	•	•		•	<i>Carya</i> spp.		AWC
<i>Myzus (Nectarosiphon) persicae</i> (Sulzer)	•	•		•	<i>Prunus persica</i> , <i>Prunus</i> spp.	polyphagous, over 40 families	AWC
<i>Myzocallis</i> sp.		•			Fagaceae		AWT
<i>Nearctaphis bakeri</i> (Cowen)	•	•		•	Crataegus, Cydonia, Malus, Pyrus	Leguminosae	AWC
<i>Nearctaphis clydesmithi</i> Hille Ris Lambers		•		•	Crataegus	unknown	AWT
<i>Nearctaphis crataegifoliae</i> (Fitch)	•			•	<i>Crataegus</i> spp.	<i>Trifolium</i> spp.	AWC
<i>Ovatus crataegarius</i> (Walker)		•		•	<i>Crataegus</i> spp.	Labiatae esp <i>Mentha</i>	AWT
<i>Pemphigus populicaulis</i> Fitch			•	•	<i>Populus deltoides</i> , <i>P. tremuloides</i>	unknown	AWT
<i>Pemphigus populitransversus</i> Riley		•		•	<i>Populus</i> spp.	Cruciferae	AWC
<i>Pemphigus populivenerae</i> Fitch		•		•	<i>Populus</i> spp.	Chenopodiaceae	AWT
<i>Periphyllus americanus</i> Baker				•	<i>Acer</i> spp.		AWT
<i>Periphyllus testudinaceus</i> (Fermi)		•			<i>Acer</i> spp., <i>Aesculus</i> spp.		AWT
<i>Phorodon humuli</i> (Schrank)		•			<i>Prunus</i> spp.	<i>Humulus lupulus</i> (hops)	AWC
<i>Prociophilus (Meliarhizophagus) fraxinifolii</i> (Riley)				•	<i>Fraxinus</i> spp.		AWT
<i>Pterocomma bicolor</i> (Oestlund)				•	<i>Populus</i> spp., <i>Salix</i> spp.		AWT
<i>Pterocomma smithiae</i> (Monell)				•	<i>Populus</i> spp., <i>Salix</i> spp.		AWT
<i>Rhodobium porosum</i> (Sanderson)			•				
<i>Rhopalomyzus poae</i> (Gillette)		•		•	<i>Lonicera alpigena</i>	grasses	AWC
<i>Rhopalosiphoninus latysiphon</i> (Davidson)		•		•	bulbs (<i>Tulipa</i> , <i>Gladiolus</i>), runners		AWC
<i>Rhopalosiphum maidis</i> (Fitch)	•	•		•	Gramineae		AWC
<i>Rhopalosiphum nymphaeae</i> (L.)				•	<i>Prunus</i> spp.	water plants	AWC
<i>Rhopalosiphum oxycanthae</i> (Schrank)	•	•			Alus, Pyrus, Cotoneaster, Crataegus, Sorbus	grasses	AWC
<i>Rhopalosiphum padi</i> (L.)	•	•		•	<i>Prunus virginiana</i>	Gramineae	AWC
<i>Rhopalosiphum rufiabdominale</i> (Sasaki)	•	•		•	<i>Prunus</i> spp.	Gramineae, Cyperaceae, Solanaceae	AWC
<i>Schizaphis graminum</i> (Rondani)		•		•	Gramineae		AWC
<i>Sipha flava</i> (Forbes)	•	•		•	Gramineae		AWC

TABLE 2. (CONTINUED) 3 SPECIES OF ALATE APHIDS WITH HOST ASSOCIATIONS, COLLECTED FROM WATER PAN TRAPS IN COMMERCIAL SNAP BEAN FIELDS IN PENNSYLVANIA (2004–2006) AND NY (2002–2006), AND FROM SIMILAR TRAPS IN PEACH ORCHARDS IN CENTRAL PENNSYLVANIA (2003–2004, WALLIS ET AL. 2005). PRIMARY AND SECONDARY HOST PLANT ASSOCIATIONS FOR NORTH AMERICA TAKEN FROM BLACKMAN & EASTOP (1994 [AWT], 2000 [AWC], AND 2006 [HPS]).

Aphid Species	Crop Sampled				Primary Host for Aphid	Secondary Host for Aphid	Source
	Snap bean		Peach				
	PA	NY	PA				
<i>Sitobion avenae</i> (Fabricius)	•	•			Gramineae		AWC
<i>Tetraneura nigribdominalis</i> (Sasaki)		•		•	<i>Ulmus</i> spp.	Gramineae	AWC
<i>Therioaphis</i> (<i>Rhizoberlesia</i>) <i>riehmi</i> (Börner)		•			<i>Melilotus</i> spp.		HPS
<i>Therioaphis</i> (<i>Pterocallidium</i>) <i>trifolii</i> (Monell)	•	•		•	Leguminosae		AWC
<i>Uroleucon</i> (<i>Lambersius</i>) <i>anomala</i> e (Hottes & Frison)					<i>Aster novaeangliae</i>		HPS
<i>Uroleucon pseudambrosiae</i> (Olive)		•			Compositae, <i>Lactuca</i> spp.		HPS
<i>Utamphorophora crataegi</i> (Monell)		•			<i>Crataegus</i> spp.		AWT
<i>Vesiculaphis caricis</i> (Fullaway)		•			<i>Rhododendron</i> spp.	<i>Cyperus</i> spp.	HPS

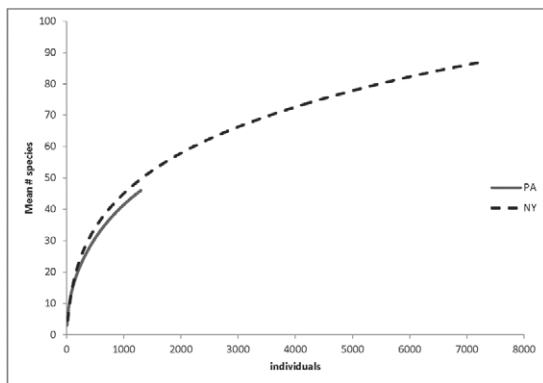


Fig. 2. Individual-based rarefaction curves showing aphid species accumulation in Pennsylvania and New York.

introduced to North America (*A. glycines* from Asia and *T. trifolii* from Europe) and were quite destructive to crops immediately after their introduction (in soybean and alfalfa, respectively). *Aphis glycines* continues to cause significant economic damage in soybean (Ragsdale et al. 2011). While not known to colonize *Phaseolus* spp., both species are competent vectors of the legume strain of CMV (Gildow et al. 2008).

The intermittent appearance of CMV in central Pennsylvania snap bean crops could be influenced by a unique agricultural landscape. Agricultural fields are located in valleys bordered by the low, but steep, forested ridges of the Appalachian Mountains. The ridge and valley system might be acting like a barrier, keeping CMV out for most of the season. We did not search for a CMV reservoir outside of testing a few alfalfa fields, which were also negative for CMV. It is possible, that much like our *A. glycines* population, legume strains of CMV

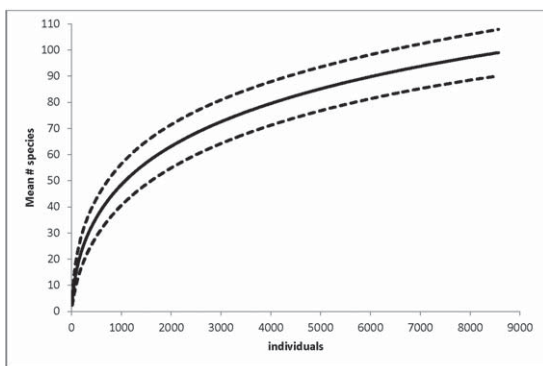


Fig. 3. Individual-based rarefaction curve showing aphid species accumulation from the combining of samples from PA and NY (solid line) and the 95% confidence intervals for the curve (dashed lines).

may be transient. If this is the case, migrating aphids may be scrubbed of virions when they land in one of the many bordering forests containing many non-host plants.

The Pepper (1965) aphid list in addition to the Pepper slide collection allowed us to compile a comprehensive list of the aphids present in Pennsylvania, but the nomenclature was in need of updating. Our efforts to update the nomenclature, and incorporate our more recent sampling efforts, resulted in a modern list of aphids of Pennsylvania that includes recently introduced species.

ACKNOWLEDGEMENTS

The authors would like to thank Fred Gildow, William Sackett and Dana Roberts. Funding for this work was provided by the Pennsylvania Vegetable Growers Association.

REFERENCES CITED

- AGRIOS, G. N. 2005. Plant Pathology, 5th ed. Elsevier Academic Press. Burlington, MA. 922 pp.
- BLACKMAN, R. L., AND EASTOP, V. F. 1994. Aphids on the World's Trees: An Identification and Information Guide. J. Wiley & Sons. Chichester, UK. 987 pp.
- BLACKMAN, R. L., AND EASTOP, V. F. 2000. Aphids on the World's Crops: An Identification and Information Guide, 2nd ed. J. Wiley & Sons. Chichester, UK. 250 pp.
- BLACKMAN, R. L., AND EASTOP, V. F. 2006. Aphids on the World's Herbaceous Plants and Shrubs (Volume 1 Host Lists and Keys; Volume 2, The Aphids). J. Wiley & Sons. Chichester, UK. 1439 pp.
- BLACKMAN, R. L., AND EASTOP, V. F. Aphids on the World's Plants. Available from <http://www.aphidsonworldsplants.info/>.
- COLWELL, R. K. 2005. EstimateS: Statistical estimation of species richness and shared species from samples Version 8.2.0. Available from <http://purl.oclc.org/estimates>.
- DAMSTEEGT, V., STONE, A. L., LUSTER, D. G., GILDOW, F. E., LEVY, L., AND WELLIVER, R. 2001. Preliminary characterization of a North American isolate of plum pox virus from naturally occurring peach and plum orchards in Pennsylvania, USA. Acta Hort. 550: 145-152.
- DIXON, A. F. G. 1985a. Aphid Ecology. Blackie & Son Ltd. London, UK. 157 pp.
- DIXON, A. F. G. 1985b. Structure of aphid populations. Annu. Rev. Entomol. 30(1):155-174.
- DIXON, A. F. G., KINDLMANN, P., LEPS, J., AND HOLMAN, J. 1987. Why are there so few species of aphids, especially in the tropics. American Nat. 129:580-592.
- FAVRET, C. Aphid Species File Version 1.0/4.1. Available from <http://aphid.speciesfile.org>.
- GILDOW, F. E., SHAH, D. A., SACKETT, W. M., BUTZLER, T., NAULT, B. A., AND FLEISCHER, S. J. 2008. Transmission efficiency of Cucumber mosaic virus by aphids associated with virus epidemics in snap bean. Phytopathology 98: 1233-1241.

- GRAY, S. M., AND BANERJEE, N. 1999. Mechanisms of arthropod transmission of plant and animal viruses. *Microbiol. Mol. Biol. Rev.* 63:128-48.
- GRIMALDI, D., AND ENGEL, M. 2005. *The Evolution of the Insects*. Cambridge University Press. Cambridge, UK. 772 pp.
- JONES, R. A. C., COUTTS, B. A., LATHAM, L. J., AND MCKIRDY, S. J. 2008. *Cucumber mosaic virus* infection of chickpea stands: temporal and spatial patterns of spread and yield-limiting potential. *Plant Pathol.* 57: 842-853.
- LARSEN, R. C., MIKLAS, P. N., EASTWELL, K. C., GRAU, C. R., AND MONDJANA, A. 2002. A virus disease complex devastating late season snap bean production in the Midwest. Annual Report of the Bean Improvement Coop. 45: 36-37.
- LEONARD, M. D. 1963. A list of the aphids of New York. *Proc. Rochester Acad. Sci.* 10: 289-428.
- MILLER, R. United States National Collection of Aphididae. Available from <http://www.sel.barc.usda.gov/aphid/aphframe.htm>.
- NAULT, B. A., SHAH, D. A., DILLARD, H. R., AND MCFAUL, A. C. 2004 Seasonal and spatial dynamics of alate aphid dispersal in snap bean fields in proximity to alfalfa and implications for virus management. *Environ. Entomol.* 33:1593-1601.
- NAULT, B. A., SHAH, D. A., STRAIGHT, K. E., BACHMANN, A. C., SACKETT, W. M., DILLARD, H. R., FLEISCHER, S. J., AND GILDOW, F. E. 2009. Modeling temporal trends in aphid vector dispersal and cucumber mosaic virus epidemics in snap bean. *Environ. Entomol.* 38:1347-59.
- NG, J. C. K., AND FALK, B. W. 2006. Virus-vector interactions mediating nonpersistent and semipersistent transmission of plant viruses. *Annu. Rev. Phytopathol.* 44: 183-212.
- PEPPER, J. O. 1965. A list of the Pennsylvania Aphididae and their host plants (Homoptera). *Trans. American Entomol. Soc.* 91: 181-231.
- PFLEEGER, T. G., OLSZYK, D., BURDICK, C. A. KING, G., KERN, J., AND FLETCHER, J. 2006. Using a geographic information system to identify areas with potential for off-target pesticide exposure. *Environ. Toxicol. Chem.* 25(8): 2250-2259.
- SMITH, C., ECKEL, R., AND LAMPERT, E. 1992. A key to many of the common alate aphids of North Carolina (Aphididae: Homoptera). *North Carolina Agric. Res. Serv. Tech. Bull.* 299.
- RAGSDALE, D. W., LANDIS, D. A., BRODEUR, J., HEIMPEL, G. E., AND DESNEUX, N. 2011. Ecology and Management of the Soybean Aphid in North America. *Annu. Rev. Entomol.* 56: 375-399.
- RAGSDALE, D. W., VOEGLTLIN, D. J., AND O'NEIL, R. J. 2004. Soybean aphid biology in North America. *Ann. Entomol. Soc. America* 97(2): 204-208.
- ROSALES, M., HINRICHSSEN, P., AND HERRERA G. 1998. Molecular characterization of plum pox virus isolated from apricots, plums, and peaches in Chile. *Acta Hort.* 472: 401-405.
- ROY, S., AND SMITH, I. M. 1994. Plum pox situation in Europe. *European Plant Prot. Org. (EPPO) Bull.* 24: 515-523.
- WALLIS, C. M., FLEISCHER, S. J., LUSTER, D., AND GILDOW, F. E. 2005. Aphid (Hemiptera: Aphididae) species composition and potential aphid vectors of plum pox virus in Pennsylvania peach orchards. *J. Econ. Entomol.* 98: 1441-50.
- WEBB, S. E., KOK-YOKOMI, M. L., AND VOEGLTLIN, D. J. 1994. Effect of trap color on species composition of alate aphids (Homoptera: Aphididae) caught over watermelon plants. *Florida Entomol.* 77: 146-154.
- ZITTER T. A., AND MURPHY, J. F. 2009. Cucumber mosaic virus. The Plant Health Instructor. Available from <http://www.apsnet.org/edcenter/intropp/lessons/viruses/Pages/Cucumbermosaic.aspx>. Accessed 28-V-2012.