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

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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 recienes 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 especimenes 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*, b*ean yellow mosaic virus*, *clover yellow mosaic virus*, *clover yellow vein virus* (ClYVV), *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 Pennsylvania. 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.
Acyrthosiphon kondoi	•	
Aphis glycines	•	
Aphis lugentis		•
Aphis (Protaphis) middletonii	•	•
Aphis pulchella		•
Nearctaphis clydesmithi		•
Tetraneura nigriabdominalis		•

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

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

Abstrusomyzus phloxae (Sampson)
Acuticauda solidaginifoliae (Williams)
Acyrthosiphon kondoi
Acyrthosiphon lactucae (Passerini)
Acyrthosiphon malvae (Mosley)
Acyrthosiphon pisum
Acyrthosiphon pseudodirhodum (Patch)
Amphorophora agathonica Hottes
Amphorophora ampullata Buckton
Amphorophora rossi Hottes & Frison
Amphorophora rubi
Amphorophora sensoriata Mason
Aulacorthum solani

Brachycaudus (Prunaphis) cardui (L.)
Brachycaudus helichrysi(Kaltenbach)
Brachycaudus (Scrophulaphis)persicae group
Brachycaudus (Brachycaudina) rociadae (Cockerell)
Brachycaudus (Thuleaphis) rumexicolens (Patch)
Brachycaudus (Appelia) schwartzi (Börner)
Brachycorynella asparagi (Mordvilko)
Brevicoryne brassicae

Cachryphora canadensis Hille Ris Lambers
Cachryphora serotinae (Oestlund)
Capitophorus carduinus (Walker)
Capitophorus elaeagni
Capitophorus hippophaes
Carolinaia caricis Wilson
Carolinaia (Galbromyzus) howardii (Wilson)
Carolinaia (Glabromyzus) rhois
Catamergus Kickapoo (Hottes & Frison)
Cavariella aegopodii (Scopoli)
Cavariella cicutae (Koch)
Cavariella hendersoni Knowlton & Smith
Cavariella pastinacae (L.)
Cavariella salicis (Monell)
Cavariella theobaldi (Gillette & Bragg)
Ceruraphis eriophori (Walker)
Ceruraphis viburnicola (Gillette)
Chaetosiphon (Pentatrichopus) fragaefolii (Cockerell)
Chaetosiphon (Pentatrichopus) minor (Forbes)
Chaetosiphon (Pentatrichopus) tetrarhodum (Walker)
Coloradoa rufomaculata (Wilson)
Cryptomyzus ribis (L.)

Decorosiphon corynothrix Börner
Diuraphis (Holcaphis) holci (Hille Ris Lambers) *Dysaphis (Pompahis) plantaginea*
Dysaphis tulipae

Ericaphis scammelli (Mason)
Ericaphis wakibae (Hottes)

Hayhurstia atriplicis
Hyadaphis foeniculi
Hyalomyzus collinsoniae (Pepper)
Hyalomyzus eriobotryae (Tissot)
Hyalomyzus mitchellensis Smith
Hyalomyzus sensoriatus (Mason)
Hyalopteroides humilis (Walker)
Hyperomyzus lactucae
Hyperomyzus (Neonasonovia) nabali (Oestlund)
Hyperomyzus (Neonasonovia) picridis (Börner & Blunck)

Idiopterus nephrelepidis Davis
Illinoia azalea (Mason)
Illinoia borealis (Mason)
Illinoia canadensis (MacGillivray)
Illinoia goldmaryae (Knowlton)
Illinoia liriodendri
Illinoia pepperi (MacGillivray)
Illinoia (Masonaphis) rhokalaza (Tissot & Pepper)
Illinoia richardsi (MacGillivray)
Illinoia (Oestlundia) rubicola (Oestlund)
Illinoia spiraecola (Patch)

Linosiphon sanguinarium (Hottes & Frison)
Liosomaphis berberidis (Kaltenbach)
Lipaphis pseudobrassicae
Longicaudus trirhodus (Walker)

Macrosiphoniella abrotani (Walker)
Macrosiphoniella frigidicola Gillette & Palmer
Macrosiphoniella leucanthemi (Ferrari)
Macrosiphoniella ludovicianae
Macrosiphoniella millefolii (De Geer)
Macrosiphoniella (Phalangomyzus) pennsylvanica (Pepper)
Macrosiphoniella sanborni
Macrosiphoniella subterranean (Koch)
Macrosiphoniella tanacetaria (Kaltenbach)
Macrosiphoniella tapuskae (Hottes & Frison)

Macrosiphum adianti (Oestlund)
Macrosiphum californicum (Clarke)
Macrosiphum (Neocorylobium) carpinicolens Patch
Macrosiphum (Neocorylobium) coryli Davis
Macrosiphum cystopteris Robinson
Macrosiphum euphorbiae
Macrosiphum gaurae (Williams)
Macrosiphum gei (Koch)
Macrosiphum geranii (Oestlund)
Macrosiphum lilii (Monell)
Macrosiphum pallidum(Oestlund)
Macrosiphum (Neocorylobium) pseudocoryli
Macrosiphum ptericolens Patch
Macrosiphum rosae
Macrosiphum tiliae (Monell)
Mastopoda pteridis Oestlund
Metopolophium dirhodum (Walker)
Microlophium sibiricum (Mordvilko)
Microparsus desmodiorum Smith & Tuatay
M icroparsus olivei Smith & Tuatay
Microparsus singularis (Hottes & Frison)
Muscaphis music Börner
Myzaphis rosarum (Kaltenbach)
Myzodium modestum (Hottes)
Myzus cerasi (Fabricius)
Myzus formosanus Takahashi
Myzus lythri (Schrank)
Myzus ornatus Liang
Myzus (Nectarosiphon) persicae

Nasonovia (Kakima) aquilegiae (Essig)
Nasonovia compositellae (Theobald)
Nasonovia (Kakima) cynosbati (Oestlund)
Nasonovia (Kakima) heucherae (Thomas)
Nasonovia (Ranakimia) purpurascens (Oestlund)
Nasonovia ribisnigri (Mosley)
Nearctaphis bakeri
Nearctaphis clydesmithi
Nearctaphis crataegifoliae
Neomyzus circumflexus (Buckton)
Neotoxoptera formosana (Takahashi)
Neotoxoptera violae (Pergande)

Ovatus crataegarius

Table 5. (Continued) Species in the subfamily Aphidinae, tribe Macrosiphini occurring in Pennsylvania.

Papulaphis sleesmani (Pepper)	*Uroleucon ambrosiae* (Thomas)	*Uroleucon nigrotibium* (Olive)
Phorodon humuli	*Uroleucon anomalae*	*Uroleucon nigrotuberculatum* (Olive)
Pleotrichophorus ambrosiae Hille Ris Lambers	*Uroleucon (Lambersius) caligatum* (Richards)	*Uroleucon obscuricaudatum* (Olive)
Pleotrichophorus asterifoliae (Strom)	*Uroleucon chrysanthemi* (Oestlund)	*Uroleucon paucosensoriatum* (Hille Ris Lambers)
Pleotrichophorus glandulosus (Kaltenbach)	*Uroleucon chrysopsidicola* (Olive)	*Uroleucon pepperi* (Olive)
Pleotrichophorus patonkus (Hottes & Frison)	*Uroleucon (Lambersius) erigeronense* (Thomas)	*Uroleucon pieloui* (Richards)
Pleotrichophorus wasatchii (Knowlton)	*Uroleucon eupatoricolens* (Patch)	*Uroleucon pseudambrosiae*
Pseudacaudella rubida Börner	*Uroleucon (Uromelan) eupatorifoliae* (Tissot)	*Uroleucon rudbeckiae* (Fitch)
	Uroleucon floricola Robinson	*Uroleucon (Uromelan) rurale* (Hottes & Frison)
Rhodobium porosum	*Uroleucon (Lambersius) gravicorne* (Patch)	*Uroleucon russellae* (Hille Ris Lambers)
Rhopalosiphoninus latysiphon	*Uroleucon (Uromelan) helianthicola* (Olive)	*Uroleucon sonchellum* (Monell)
Rhopalosiphoninus (Myzosiphon) solani (Thomas)	*Uroleucon (Uromelan) illini* (Hottes & Frison)	*Uroleucon sonchi* (L.)
Rhopalosiphoninus staphyleae (Koch)	*Uroleucon impatiensicolens* (Patch)	*Uroleucon (Uromelan) taraxaci* (Kaltenbach)
Rhopalomyzus (Judenkoa) lonicerae (Siebold)	*Uroleucon lanceolatum* (Patch)	*Uroleucon (Uromelan) tardae* (Hottes & Frison)
Rhopalomyzus poae (Gillette)	*Uroleucon leonardi* (Olive)	*Uroleucon (Uromelan) tuataiae* Olive
Sitobion avenae	*Uroleucon (Lambersius) luteolum* (Williams)	*Utamphorophora crataegi*
		Utamphorophora humboldti (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-

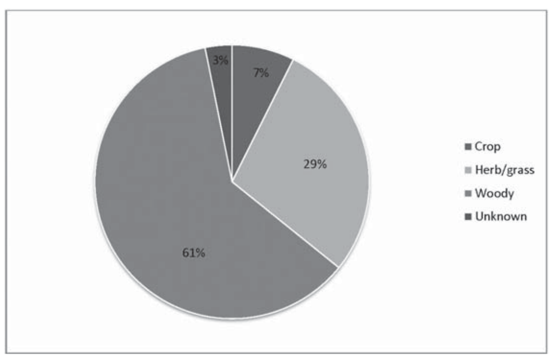

Fig. 1. Proportion of aphids from the pan trapping collection in Pennsylvania and New York that use herbaceous plants, trees, or crops as primary hosts. Host associations for North America characterized from Blackman & Eastop (1994, 2000, 2006).

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

Aphis angelicae Lee & Seo
Aphis asclepiadis Fitch
Aphis caliginosa Hottes & Frison
Aphis carduella
Aphis cephalanthi
Aphis coreopsidis (Thomas)
Aphis cornifoliae Fitch
Aphis craccivora
Aphis debilicornis Gillette & Palmer
Aphis decepta Hottes & Frison
Aphis fabae
Aphis farinosa Gmelin
Aphis feminea Hottes
Aphis folsomii Davis
Aphis forbesi Weed
Aphis frangulae Kaltenbach
Aphis gerardiae (Thomas)
Aphis glycines
Aphis gossypii
Aphis hamamelidis Pepper
Aphis hederae
Aphis illinoisensis Shimer
Aphis impatientis Thomas
Aphis (Protaphis) knowltoni Hottes & Frison
Aphis lugentis
Aphis maculatae Oestlund
Aphis (Protaphis) middletonii
Aphis nasturtii
Aphis neilliae Oestlund
Aphis nerii Boyer de Fonscolombe
Aphis (Bursaphis) oenotherae Oestlund
Aphis oenotherae sanborni
Aphis oestlundi
Aphis pawneepae Hottes
Aphis pomi
Aphis pulchella
Aphis rubicola Oestlund
Aphis rubifolii
Aphis rumicis
Aphis sambuci (L.)
Aphis spiraecola
Aphis spiraephila Patch
Aphis (Burspahis) varians Patch
Aphis vernoniae Thomas
Aphis viburniphila
Hyalopterus pruni
Hysteroneura setariae

Pseudasiphonaphis corni (Tissot)

Rhopalosiphum cerasifoliae (Fitch)
Rhopalosiphum enigma Hottes & Frison
Rhopalosiphum maidis
Rhopalosiphum musae (Schouteden)
Rhopalosiphum nigrum Richards
Rhopalosiphum nymphaeae
Rhopalosiphum oxyacanthae
Rhopalosiphum padi
Rhopalosiphum parvae Hottes & Frison
Rhopalosiphum rufiabdominale
Rhopalosiphum sanguinarium McVicar Baker

Sanbornia juniper Pergande ex Baker
Schizaphis graminum
Schizaphis nigra (Baker)

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

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

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

Tribe	Species		
Chaitophorini	*Chaitophorus longipesi* Tissot	*Chaitophorus populifolii*	*Chaitophorus viminicola* Hille Ris Lambers
	Chaitophorus nigrae Oestlund	*Chaitophorus pusillus* Hottes & Frison	*Periphyllus americanus*
	Chaitophorus nigricentrus Richards	*Chaitophorus saliniger* Shinji	*Periphyllus californiensis* (Shinji)
	Chaitophorus nudus Richards	*Chaitophorus stevensis* Sanborn	*Periphyllus lyropictus* (Kessler)
	Chaitophorus populicola Thomas	*Chaitophorus viminalis* Monell	*Periphyllus negundinis* (Thomas)
	Chaitophorus populifoliae Oestlund		
Siphini	*Sipha (Rungsia) elegans* del Guercio	*Sipha flava*	*Sipha glyceriae*

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 (Pfleeger 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.

Drepanaphis acerifoliae	*Drepanaphis nigricans*	*Drepanaphis spicata* Smith
Drepanaphis carolinensis	*Drepanaphis parva* Smith	*Drepanosiphum platanoidis*
Drepanaphis kanzensis Smith	*Drepanaphis sabrinae* Miller	*Shenahweum minutum* (Davis)
Drepanaphis monelli Davis	*Drepanaphis simpsoni* Smith	

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

Tribe	Species		
Eriosomatini	*Colopha graminis* (Monell)	*Eriosoma lanigerum*	*Eriosoma wilsoni* Remaudière
	Colopha ulmicola (Fitch)	*Eriosoma (Mimaphidus) lanuginosum* (Hartig)	*Kaltenbachiella ulmifusa* (Walsh & Riley)
	Eriosoma americanum (Riley)	*Eriosoma mimicum* Hottes & Frison	*Tetraneura nigriabdominalis*
	Eriosoma crataegi (Oestlund)	*Eriosoma rileyi* Thomas	*Tetraneura ulmi* (L.)
Fordini	*Forda marginata* Koch	*Melaphis rhois*	
	Geoica ultricularia group	*Smynthurodes betae* Westwood	
Pemphigini	*Grylloprociphilus imbricator* (Fitch)	*Pemphigus populitransversus*	*Prociphilus longianus* Smith
	Mordwilkoja vagabunda (Walsh)	*Pemphigus populivenae*	*Prociphilus (Pulvius) probosceus* (Sanborn)
	Neoprociphilus aceris (Monell)	*Prociphilus americanus* (Walker)	*Prociphilus (Paraprociphilus) tessellatus* (Fitch)
	Pachypappa pseudobyrsa (Walsh)	*Prociphilus caryae caryae* (Fitch)	*Thecabius affinis* (Kaltenbach)
	Pemphigus bursarius (L.)	*Prociphilus caryae* spp. *fitchii* Baker & Davidson	*Thecabius (Parathecabius) gravicornis* (Patch)
	Pemphigus monophagus Maxson	*Prociphilus (Neoparacletus) corrugatans* (Sirrine)	*Thecabius populimonilis* (Riley)
	Pemphigus nortonii Maxson	*Prociphilus erigeronensis* (Thomas)	
	Pemphigus populicaulis	*Prociphilus (Meliarhyzophagus) fraxinifolii*	

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

Tribe	Species		
Eulachnini	*Cinara atlantica*	*Cinara juniperivora* (Wilson)	*Cinara taedae* Tissot
	Cinara banksiana Pepper & Tissot	*Cinara laricifex* (Fitch)	*Cinara (Cupressobium) tujafilina* (Del Guercio)
	Cinara braggii (Gillette)	*Cinara laricis* (Hartig)	*Cinara watsoni* Tissot
	Cinara canatra Hottes & Bradley	*Cinara pergandei* (Wilson)	*Essigella pini*
	Cinara costata (Zetterstedt)	*Cinara pilicornis* (Hartig)	*Eulachnus agilis* (Kaltenbach)
	Cinara (Cupressobium) cupressi (Buckton)	*Cinara pinea* (Mordvilko)	*Eulachnus americanus* Takahashi
	Cinara fornacula Hottes	*Cinara pinivora* (Wilson)	*Eulachnus rileyi*
	Cinara gracilis (Wilson)	*Cinara pruinosa* (Hartig)	*Schizolachnus parvus* (Wilson)
	Cinara harmonia Hottes	*Cinara spiculosa* Bradley	*Schizolachnus piniradiatae* (Davidson)
	Cinara juniperi De Geer	*Cinara strobe* Fitch	
Lachnini	*Lachnus allegheniensis* McCook	*Tuberolachnus salignus* (Gmelin)	
	Longistigma caryae (Harris)		
Tramini	*Trama rara* Mordvilko		

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

	New York		Pennsylvania		Overall	
Species	Total	Percent of Total	Total	Percent of Total	Total	Percent of Total
Therioaphis trifolii (Monell)	2,274	30.4	535	40.0	2809	31.8
Aphis glycines Matsumura	1,475	19.7	131	9.8	1606	18.2
Acyrthosiphon pisum (Harris)	1,106	14.8	28	2.1	1134	12.9
Rhopalosiphum maidis (Fitch)	685	9.2	75	5.6	760	8.6
Pemphigus populicaulis Fitch	239	3.2	0	0.0	239	2.7
Aphis craccivora Koch	179	2.4	123	9.2	302	3.4
Aphis gossypii Glover	130	1.7	201	15.0	331	3.8
Hayhurstia atriplicis (L.)	128	1.7	1	0.1	129	1.5
Lipaphis pseudobrassicae (Davis)*	128	1.7	0	0.0	128	1.5
Myzus persicae (Sulzer)	97	1.3	26	1.9	123	1.4
Capitophorus eleagni (Del Guerica)	79	1.1	7	0.5	86	1.0
Aphis sp.	77	1.0	0	0.0	77	0.9
Rhopalosiphum padi (L.)	77	1.0	45	3.4	122	1.4
Aphis fabae Scopoli	15	0.2	14	1.0	29	0.3
Anoecia sp.	1	<0.1	14	1.0	15	0.2
Brachycaudus persicae (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]).

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

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

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

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

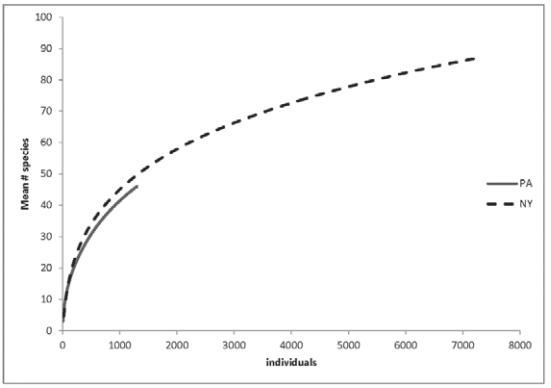

Fig. 2. Individual-based rarefaction curves showing aphid species accumulation in Pennsylvania and New York.

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 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.

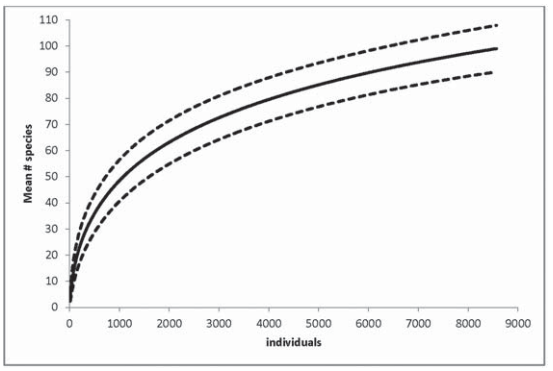

Fig. 3. Individual-based rarefaction curve showing aphid species accumulation from the combining of samples from PA and NY (solid line) and the 95% confidence intervals for the curve (dashed lines).

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.

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