BioOne COMPLETE

First Report of Native Astata unicolor (Hymenoptera: Crabronidae) Predation on the Nymphs and Adults of the Invasive Brown Marmorated Stink Bug (Hemiptera: Pentatomidae)

Authors: Biddinger, David J., and Joshi, Neelendra K.

Source: Florida Entomologist, 100(4) : 809-812

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.100.0408

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.

Downloaded From: https://bioone.org/journals/Florida-Entomologist on 11 Aug 2024
Terms of Use: https://bioone.org/terms-of-use

First report of native *Astata unicolor* (Hymenoptera: Crabronidae) predation on the nymphs and adults of the invasive brown marmorated stink bug (Hemiptera: Pentatomidae)

David J. Biddinger[1,2] and Neelendra K. Joshi[3]*

Exotic species of arthropods, including pests, can provide new food resources for native predators, and may replace their food choice of native prey with new (exotic) species (Carlsson et al. 2009). Several examples of vertebrate predators switching to invasive prey include the previously threatened Lake Erie water snake, *Nerodia sipedon insularum* (Conant & Clay, 1937) (Squamata: Colubridae), whose preferred prey is now the exotic Eurasian round goby, *Neogobius melanostomus* (Pallas, 1814) (Perciformes: Gobiidae) (King et al. 2006), and the zebra mussel, *Dreissena polymorpha* (Pallas, 1771) (Veneroida: Dreissenidae), both of which invaded the Great Lakes and became important in the diet of turtles (Bulte & Bloudin-Demers 2008) and other predators such as birds (Petrie & Knapton 1999) in this region. Using superabundant invasive prey such as these would give predators of all types, including insects, a competitive advantage over other native predators that cannot physiologically and behaviorally adapt to new (invasive) food sources (Carlsson et al. 2009). Carlsson et al. (2009) argues that native predators can be an important regulatory factor not only of native species, but over time could be important in regulating non-native species as well. The examples used by Carlsson et al. (2009) mostly are of vertebrates, but numerous examples of exotic insect pests being regulated by native arthropod species exist. Examples of this are the European red mite control by the native coccinellid mite predator, *Stethorus punctum* LeConte (Coleoptera: Coccinellidae) (Biddinger et al. 2009), or numerous native parasitic wasp species which not only help regulate native tortricid pests in apple orchards, but also codling moth and Oriental fruit moth that were introduced from Asia (Biddinger et al. 1994; Allen 1962). Here we describe how a native predatory wasp (*Astata unicolor* Say [Hymenoptera: Crabronidae]), which specializes on stink bug as prey, has adapted to using the nymphs of the invasive Asian species of stink bug known as the brown marmorated stink bug, *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae).

First reported in 1996 (Hoebeke & Carter 2003), brown marmorated stink bug is a serious pest of fruits and vegetables in the mid-Atlantic states of the USA During the 2010 season, apple growers of this region lost an estimated $37 million due to fruit injury by brown marmorated stink bug (Seetin 2011). Brown marmorated stink bug is a highly mobile polyphagous pest that can fly long distances (Bakken et al. 2015). Different stages of brown marmorated stink bug are attacked by several species of native arthropod natural enemies (Abram et al. 2017; Dieckhoff et al. 2017). As an agricultural pest, it is a good candidate for biological regulation by predators and parasitoids, because it spends the majority of the year in non-managed, wooded habitats rather than in agricultural crops where pesticides often limit biological control.

As part of a multiyear survey conducted using different traps and hand netting for native biological control agents for brown marmorated stink bug, we observed the native wasp *Bicyrtes quadrifasciata* (Say) Hymenoptera: Crabronidae), which is a stink bug specialist predator, gathering brown marmorated stink bug nymphs, which was a preferred prey when nest provisions were examined (Biddinger et al. 2017). *Bicyrtes quadrifasciata* is from a group known as sand wasps (Bohart 1996), and often is found nesting communally in large numbers in sandy areas such as sand boxes and baseball fields (Evans & O'Neill 2007). During this survey, another closely related species of Crabronidae, *A. unicolor* (Say), also was observed carrying brown marmorated stink bug nymphs as prey and was photographed by Pennsylvania nature photographer Yurika Alexander (Fig. 1).

Astata unicolor adults are extremely fast fliers and hard to follow visually, but species of *Astata* seems to prefer nesting in heavier soils along the edges of woods and gardens (Evans 1957). Females of both genera provision tunnels with paralyzed prey in underground nests up to 20 cm deep, with *Astata* being more specialized in using only stink bug nymphs, whereas *Bicyrtes* also may use other hemipterans such as Coreidae, Alydididae, and Rophalidae, in addition to Pentatomidae. Nest provisioning strategies also differ between the 2 genera, with *Bicyrtes* digging 5 to 6 tunnel nests during her lifetime, with each tunnel having 1 to 3 cells, and each cell containing from 4 to 14 prey nymphs. In contrast, the smaller *Astata* females appear to dig only a single nest that may have from 12 to 14 provisioning cells, but with only 2 to 3 prey nymphs per cell and only a single egg laid in each cell (Evans 1957; Evans 1962; Parker 1962; Evans & O'Neil 2007).

While monitoring bees and other pollinators weekly with different types of visual pan and vane traps from 1 Apr to the end of Oct as described in Joshi et al. (2015), *A. unicolor* adults were not captured in 6 commercial apple and 4 commercial cherry orchards from 2010-2015. In concurrent monitoring of nearby floral provisioning strips consisting of many species of perennial native wild flowers to enhance pollinator populations, as described in Shugrue (2016), a total of 48 adults of *A. unicolor* were captured either by pan trap, vane trap, or by net

[1]Fruit Research & Extension Center, Entomology, Pennsylvania State University, 290 University Dr., Biglerville, Pennsylvania 17307, USA, E-mail: djb134@psu.edu (D. J. B.)
[2]Department of Entomology, 501 ASI Building, Pennsylvania State University, University Park, Pennsylvania 16802, USA
[3]Department of Entomology, 319 AGRI Building, University of Arkansas, Fayetteville, Arkansas 72701, USA, E-mail: nkjoshi@uark.edu (N. K. J.)
*Corresponding author; Email: nkjoshi@uark.edu

Downloaded From: https://bioone.org/journals/Florida-Entomologist on 11 Aug 2024
Terms of Use: https://bioone.org/terms-of-use

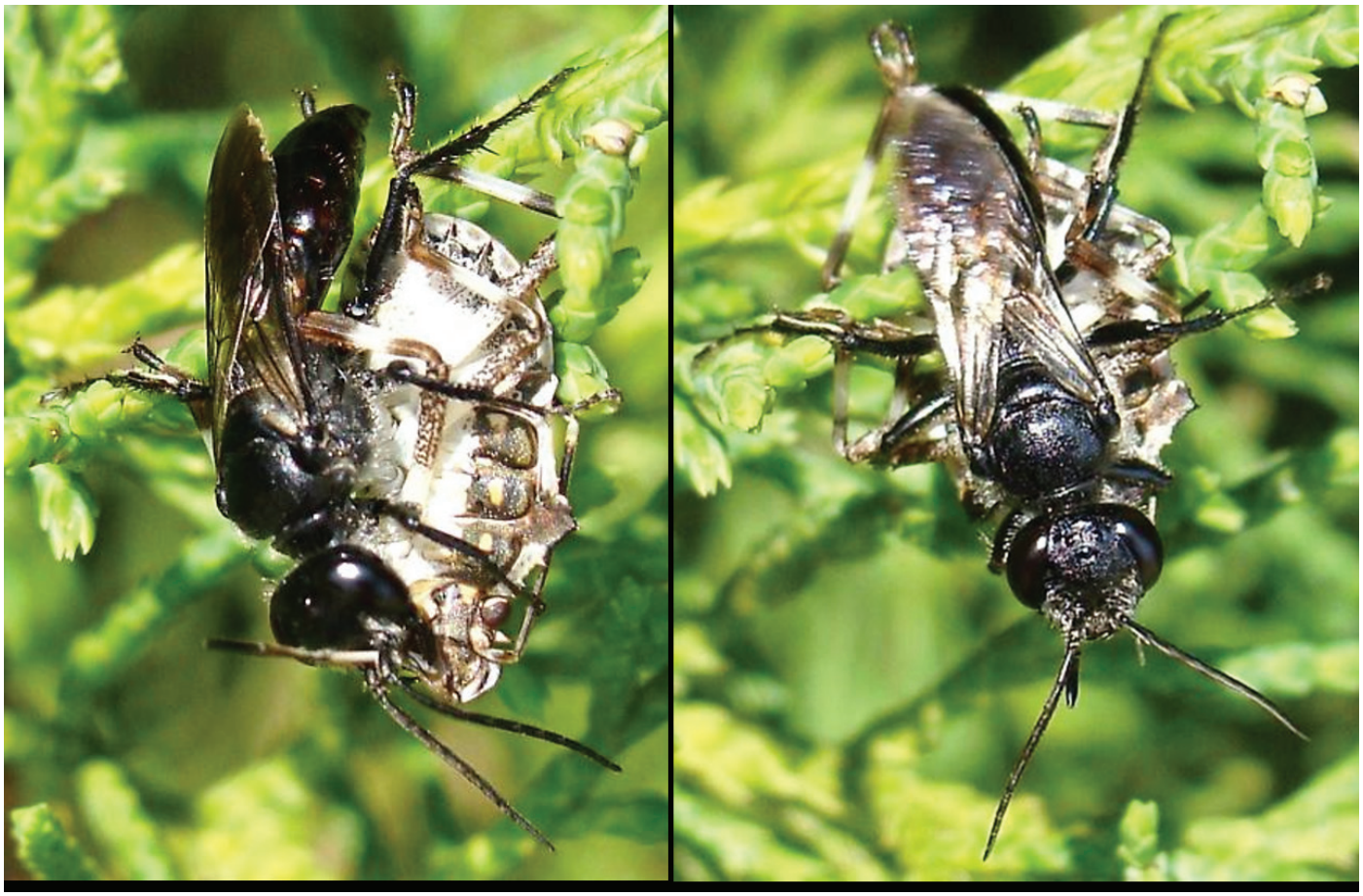

Fig. 1. *Astata unicolor* adult (female) paralyzing a brown marmorated stink bug for nest provisioning (photo by Yurika Alexander).

collection during floral visits. Seasonal capture of *A. unicolor* in 2011 and 2012 suggests only a single generation that begins at the end of Jun, peaks in mid-Aug and ends by the beginning of Oct (Fig. 2). Of these adults, only 1 was a female, and the majority were trapped in colored pan traps. Finding almost exclusively male *A. unicolor* adults captured in traps and by net is probably due to the hill-topping behavior of the males (Alcock 2007). The majority of specimens were collected through pan traps (81%) followed by net collection (13%) and captures in vane traps (6%). Among water pan traps, most specimens were found in dark blue-colored pan traps (56%), followed by white (36%) and yellow (8%) pan traps. Specimens that were net-collected directly from flowers were found foraging on wild burgemont (*Monarda fistulosa* L. [Lamiales: Lamiaceae]), wild carrot (*Daucus carota* L. [Apiales: Apiaceae]), and swamp milkweed (*Asclepias incarnata* L. [Gentianales: Apocynaceae]).

During this survey, we also observed feeding on brown marmorated stink bug adults and nymphs in the field by the common reduviid predator known as the wheel bug, *Arilus cristatus* (L.) (Hemiptera: Reduviidae) and several species of large spiders. Predation by large generalist predators such as these, however, is not unexpected.

Considering the economic importance and polyphagous nature of brown marmorated stink bug, it is important to further explore the role of these native predators in regulating the long-term population dynamics of population in the Mid-Atlantic region and elsewhere in future studies. Additionally, it is also important to investigate if this host shift of native crabronid stink bug predators is due to a preference for brown marmorated stink bug or by just default, due to the greater abundance of brown marmorated stink bug, which may have displaced native prey.

Acknowledgments

The authors are grateful to the USDA-NIFA SCRI project 2011-01413-30937, Northeast IPM Center IPM Partnership Grant and the State Horticultural Society of Pennsylvania for the financial support of this project, and Yurika Alexander for allowing the use of *Astata unicolor* photograph.

Summary

Native insect predators and parasitoids can help regulate invasive insect pest species. The brown marmorated stink bug, *Halymorpha halys* (Hemiptera: Pentatomidae), is an introduced pest of fruits and vegetables in the eastern USA that originated in Asia. Surveys for native biological control agents of this pest detected the crabronid predatory wasp *Astata unicolor* (Hymenoptera: Crabronidae) and the generalist predatory bug *Arilus cristatus* (Hemiptera: Reduviidae) using the nymphs and adults of this introduced pest as prey. Temporal distribution of the wasp was determined from water pan traps and net collections over 5 years in floral provisioning strips that were established for pollinator conservation programs in tree fruit farms. Blue vane traps used for bee monitoring did not capture *A. unicolor* in pollinator plant-

Downloaded From: https://bioone.org/journals/Florida-Entomologist on 11 Aug 2024
Terms of Use: https://bioone.org/terms-of-use

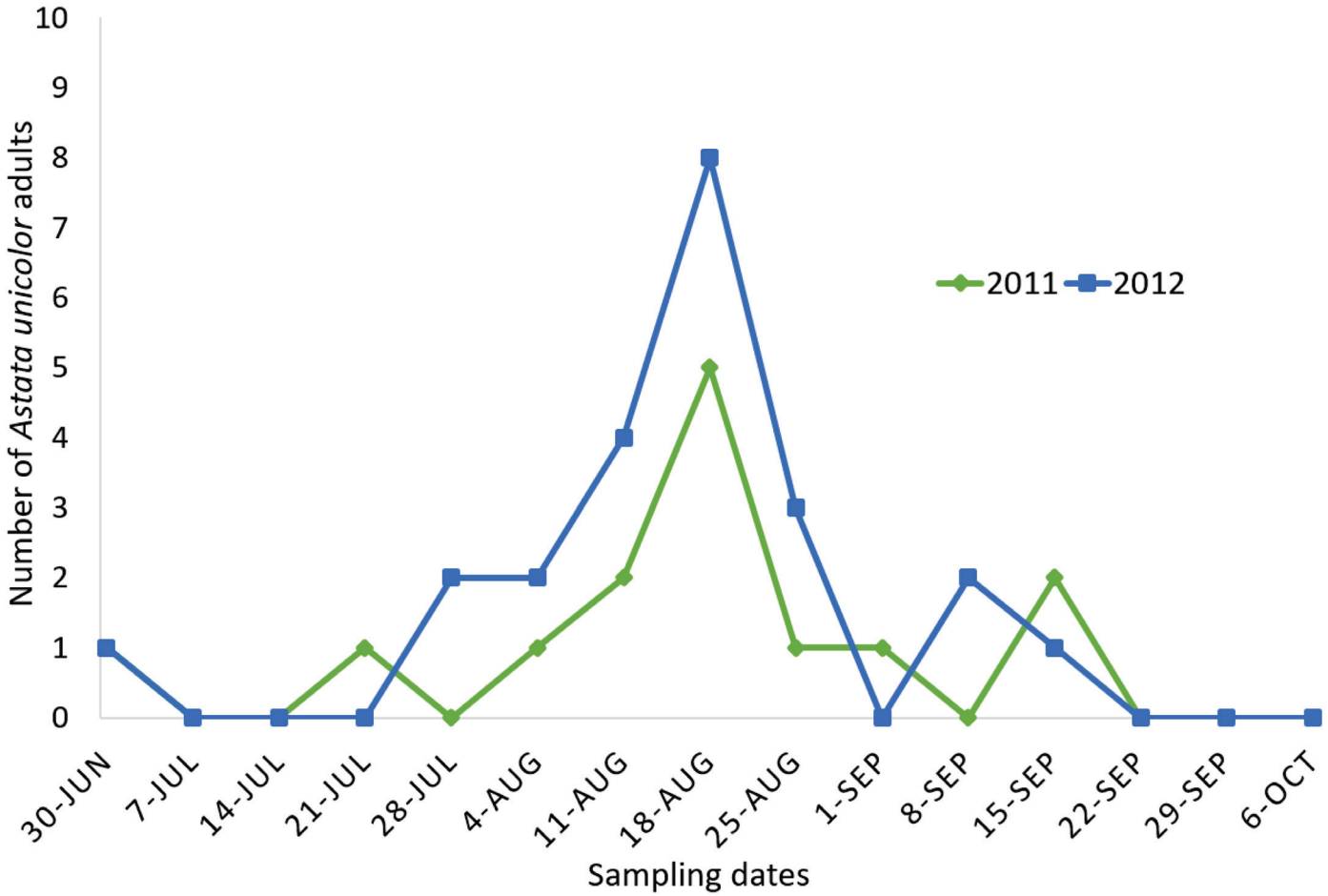

Fig. 2. Seasonal capture of *Astata unicolor* in Pennsylvania during 2011 and 2012 seasons.

ings. *Astata unicolor* was not found in 6 commercial apple orchards that were monitored concurrently using either pan or blue vane traps over a 4 yr period.

Key Words: biocontrol; invasive species; nest provision; sand wasp

Sumario

Los depredadores y parasitoides nativos de insectos pueden ayudar a regular las especies invasoras de plagas de insectos. El chinche café marmorado *Halymorpha halys* (Hemiptera: Pentatomidae,) es una plaga introducida de frutas y verduras en el este de los Estados Unidos que se originó en Asia. En los sondeos para los agentes de control biológico nativo de esta plaga se detectó la avispa predadora crabronida *Astata unicolor* (Hymenoptera: Crabronidae) y el insecto predador generalista *Arilus cristatus* (Hemiptera: Reduviidae) utilizando las ninfas y adultos de esta plaga introducida como presa. La distribución temporal de la avispa fue determinada a partir de trampas de pozo de agua y colecciones con redes durante 5 años en tiras de flores provisionales que fueron establecidas para programas de conservación de polinizadores en los huertos de árboles frutales. Las trampas de paletas azules utilizadas para el monitoreo de las abejas no capturaron *A. unicolor* en las plantas para los polinizadores. No se encontró *Astata unicolor* en 6 huertos de manzanas comerciales que fueron monitoreados simultáneamente utilizando trampas de platos y de paletas azules durante un período de 4 años.

Palabras claves: biocontrol; especies invasivas; provisión de nidos; avispa de arena

References Cited

Abram PK, Hoelmer KA, Acebes-Doria A, Andrews H, Beers EH, Bergh C, Bessin R, Biddinger D, Botch P, Buffington ML, Cornelius ML, Costi E, Delfosse ES, Dieckhoff C, Dobson R, Donais Z, Grieshop M, Hamilton G, Haye T, Hedstrom C, Herlihy M, Hoddle M, Hooks C, Jentsch P, Joshi NK, Kuhar TP, Lara J, Lee JC, Legrand A, Leskey TC, Lowenstein D, Maistrello L, Mathews CR, Milnes JM, Morrison WR, Nielsen AL, Ogburn EC, Pickett CH, Poley K, Pote J, Radl J, Shrewsbury PM, Talamas E, Tavella L, Walgenbach JF, Waterworth R, Weber DC, Welty C, Wiman NG. 2017. Indigenous arthropod natural enemies of the invasive brown marmorated stink bug in North America and Europe. Journal of Pest Science 1–12. DOI:10.1007/s10340-017-0891-7.

Alcock J. 2007. Hilltopping behavior of two species of *Astata* (Hymenoptera: Crabronidae) in central Arizona. The Southwestern Naturalist 52: 564–569.

Allen HW. 1962. Parasites of the oriental fruit moth. United States Department of Agriculture Technical Bull. No. 1285, 139 p.

Bakken AJ, Schoof SC, Bickerton M, Kamminga KL, Jenrette JC, Malone S, Abney MA, Herbert DA, Reisig D, Kuhar TP, Walgenbach JF. 2015. Occurrence of brown marmorated stink bug (Hemiptera: Pentatomidae) on wild hosts in nonmanaged woodlands and soybean fields in North Carolina and Virginia. Environmental Entomology 44: 1011–1021.

Biddinger DJ, Felland CM, Hull LA. 1994. Parasitism of tufted apple bud moth (Lepidoptera: Tortricidae) in conventional insecticide and pheromone-treated Pennsylvania apple orchards. Environmental Entomology 23: 1568–1579.

Biddinger DJ, Weber DC, Hull LA. 2009. Coccinellidae as predators of mites: Stethorini in biological control. Biological Control 51: 268–283.

Biddinger D, Surcica A, Joshi NK. 2017. A native predator utilizing the invasive brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae) as a food source. Biocontrol Science and Technology 27: 903-907. DOI: 10.1080/09583157.2017.1354247.

Bohart RM. 1996. A review of the genus *Bicyrtes* (Hymenoptera: Sphecidae, Nyssoninae, Bembicini). Insecta Mundi 10: 139–152.

Downloaded From: https://bioone.org/journals/Florida-Entomologist on 11 Aug 2024
Terms of Use: https://bioone.org/terms-of-use

Bulte G, Blouin-Demers G. 2008. Northern map turtles (*Graptemys geographica*) derive energy from the pelagic pathway through the predation of zebra mussels (*Dreissena polymorpha).* Freshwater Biology 53: 497–508.

Carlsson NO, Sarnelle O, Strayer DL. 2009. Native predators and exotic prey – an acquired taste? Frontiers in Ecology and the Environment 7: 525–532. DOI:10.1890/080093

Dieckhoff C, Tatman KM, Hoelmer KA. 2017. Natural biological control of *Halyomorpha halys* by native egg parasitoids: a multi-year survey in northern Delaware. Journal of Pest Science, 1–16. DOI:10.1007/s10340-017-0868-6.

Evans HE. 1957. Ethological studies of digger wasps of the genus *Astata* (Hymenoptera: Sphechidae). Journal of the New York Entomological Society 65: 159–185.

Evans HE. 1962. Notes on the ethology of *Astata* (Hymenoptera: Sphecidae). Journal of the New York Entomological Society 70: 30–32.

Evans HE, O'Neil KM. 2007. The sand wasps: natural history and behavior. Harvard University Press, Cambridge, Massachusetts. 340 p.

Hoebeke ER, Carter ME. 2003. *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae): A polyphagous plant pest from Asia newly detected in North America. Proceedings of the Entomological Society of Washington 105: 225–237.

Joshi NK, Leslie T, Rajotte EG, Kammerer MA, Otieno M, Biddinger DJ. 2015. Comparative trapping efficiency to characterize bee abundance, diversity and community composition in apple orchards. Annals of the Entomological Society of America 108: 785–799.

King RB, Ray JB, Stanford KM. 2006. Gorging on gobies: beneficial effects of alien prey on a threatened vertebrate. Canadian Journal of Zoology 84: 108–115.

Parker FD. 1962. On the subfamily Astatinae, with a systematic study of the genus *Asata* of America north of Mexico (Hymenoptera: Sphecidae). Annals of the Entomological Society of America 55: 643–659.

Petrie D, Knapton RW. 1999. Rapid increase and subsequent decline of zebra and quagga mussels in Long Point Bay, Lake Erie: possible influence of waterfowl predation. Journal of Great Lakes Research 25: 772–782.

Seetin M. 2011. News release: losses to mid-Atlantic apple growers at $37 million from brown marmorated stink bug. http://growingproduce.com/fruits/apples-pears/brown-marmorated-stink-bug-causes-37-million-in-losses-to-mid-atlantic-apple-growers/ (Last accessed 15 Feb 2017)

Shugrue S. 2016. Pesticide use, habitat manipulation, and management changes factors in pollinator sustainability in Pennsylvania apple orchards. M.S. thesis. The Pennsylvania State University, Department of Entomology, University Park, Pennsylvania . 85 pp.

Downloaded From: https://bioone.org/journals/Florida-Entomologist on 11 Aug 2024
Terms of Use: https://bioone.org/terms-of-use