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MARYLAND ENTOMOLOGICAL SOCIETY
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The Maryland Entomological Society (MES) was founded in November 1971, to promote the science of entomology in all its sub-disciplines; to provide a common meeting venue for professional and amateur entomologists residing in Maryland, the District of Columbia, and nearby areas; to issue a periodical and other publications dealing with entomology; and to facilitate the exchange of ideas and information through its meetings and publications. The MES was incorporated in April 1982 and is a 501(c)(3) non-profit, scientific organization.

The MES logo features an illustration of ***Euphydryas phaëton*** (Drury) (Lepidoptera: Nymphalidae), the Baltimore Checkerspot, with its generic name above and its specific epithet below (both in capital letters), all on a pale green field; all these are within a yellow ring double-bordered by red, bearing the message "● Maryland Entomological Society ● 1971 ●". All of this is positioned above the Shield of the State of Maryland. In 1973, the Baltimore Checkerspot was named the official insect of the State of Maryland through the efforts of many MES members.

Membership in the MES is open to all persons interested in the study of entomology. All members receive the annual journal, ***The Maryland Entomologist***, and the monthly e-newsletter, ***Phaëton***. Institutions may subscribe to ***The Maryland Entomologist*** but may not become members.

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Back issues of ***The Maryland Entomologist*** and recent issues of the ***Phaëton*** are available to members, via the Publications Editor: Eugene J. Scarpulla, 14207 Lakerun Court, Bowie, MD 20720-4861, ejscarp@comcast.net. Please contact the Publications Editor for availability and cost.

Meetings are held on the third Friday of October, November, February, March, April and May at 8:00 p.m. in Room 4 of the Biological Sciences Building, University of Maryland Baltimore County (UMBC), or occasionally at another announced site.

Past Presidents of the MES

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Editor's Note

This issue of The Maryland Entomologist contains five articles and notes submitted by members of the Maryland Entomological Society.

Alan W. Leslie, Chris Sargent, Warren E. Steiner, Jr., William O. Lamp, Jil M. Swearingen, Benedict B. Pagac, Jr., Gaye L. Williams, Donald C. Weber, and Michael J. Raupp report on the biology and distribution of Maryland's latest invasive species, the Kudzu Bug, *Megacopta cribraria* (Fabricius) (Hemiptera: Plataspidae).

Warren E. Steiner, Jr. details new collection records of the scarab beetle, *Rhyssemus scaber* Haldeman (Coleoptera: Scarabaeidae) from Maryland and Virginia.

Warren E. Steiner, Jr. and Jil M. Swearingen summarize species collection records of the crypticine darkling beetles (Coleoptera: Tenebrionidae: Crypticini, *Gondwanocrypticus* Español) from the Chesapeake Bay Region.

Warren E. Steiner, Jr. and Frederick Paraskevoudakis document the first Western Hemisphere record of an Asian darkling beetle, *Plesiophthalmus spectabilis* Harold (Coleoptera: Tenebrionidae: Amarygmini), that was found in Maryland in 2013.

Rebecca C. Wilson, Alan W. Leslie, Elanor Spadafora, and William O. Lamp present their investigation of nuisance black flies (Diptera: Simuliidae) of Washington County, Maryland.

This year's submitted articles and notes again show the excellent studies being conducted, and the notable discoveries being made, by members of the Maryland Entomological Society. Furthermore, three University of Maryland College Park entomology graduate students are coauthors on one or more manuscripts. Special thanks are extended to Warren E. Steiner, Jr. for authoring or coauthoring four of the manuscripts. I thank all of the authors for their submittals that further our knowledge of the insects of Maryland. I express my gratitude to the named and anonymous peer reviewers for their insightful comments that have enhanced each publication.

Eugene J. Scarpulla
Editor

A New Invasive Species in Maryland: the Biology and Distribution of the Kudzu Bug, *Megacopta cribraria* (Fabricius) (Hemiptera: Plataspidae)

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ABSTRACT: The relaxation of trade restrictions in the 1960s and -70s led to an unintended exchange of invasive insect species as well as manufactured goods between the United States and its new trade partners. Consequently, the number of exotic insect pests accidently entering and taking up residence in the United States has increased dramatically over the past several decades. A recent arrival from Asia, the Kudzu Bug, *Megacopta cribraria* (Fabricius) (Hemiptera: Plataspidae), also known as the Bean Plataspid, Lablab Bug, and Globular Stink Bug, represents a family new to this continent. Although it belongs to the stink bug infraorder Pentatomomorpha, *M. cribraria* is the only member of the family Plataspidae currently known to occur in the New World. First reported in Georgia in 2009, *M. cribraria* has spread rapidly and was confirmed in eight Maryland counties in 2013. Initially regarded as a nuisance pest by home owners, *M. cribraria* has become a serious pest of soybeans (*Glycine max* [L.] Merr. [Fabaceae]), and potentially, of other leguminous crops (Fabaceae) in its introduced range. This article summarizes the known history, biology, identification, and movement of *M. cribraria* in the United States and Maryland to date, as well as environmentally responsible integrated pest management options.

INTRODUCTION

The first record of the Kudzu Bug, *Megacopta cribraria* (Fabricius) (Hemiptera: Plataspidae) in North America occurred in 2009 when it was discovered feeding on kudzu, *Pueraria montana* (Lour.) Merr. (Fabaceae), and congregating in large numbers on the exteriors of nearby homes and vehicles in nine counties in northeastern Georgia (Eger et al. 2010, Suiter et al. 2010). This true bug is a member of the family Plataspidae

and is native to the Indian subcontinent and Asia (Srinivasaperumal et al. 1992, Hua 2000). The exact date, location, and mode of entry into the United States are unknown (Zhang et al. 2012). However, it appears that the establishment of *M. cribraria* in the United States may have occurred as the introduction of a single female line (Jenkins et al. 2010, Ruberson et al. 2012). Specimens of the invasive pest were collected in October 2009 and submitted to the University of Georgia College of Agricultural and Environmental Science (UGA-CAES) Homeowner Insect and Weed Diagnostics Laboratory for identification. The plataspid was tentatively identified by Joseph E. Eger, Jr. (Research Scientist, Dow AgroSciences, Tampa, Florida), and identification was confirmed in November 2009 by David A. Rider (Professor, Department of Entomology, North Dakota State University, Fargo, North Dakota), Susan E. Halbert (Taxonomic Entomologist , Florida Department of Agriculture & Consumer Services, Gainesville, Florida), and Thomas J. Henry (Research Entomologist, United States Department of Agriculture - Agricultural Research Service - Systematic Entomology Laboratory (USDA-ARS-SEL), Washington, DC) (Eger et al. 2010, Jenkins et al. 2010, Suiter et al. 2010). Voucher specimens are on deposit in the Florida State Collection of Arthropods, Gainesville, Florida, and the United States National Museum of Natural History, Smithsonian Institution, Washington, DC (Suiter et al. 2010).

Froeschner (1984) concluded that no species of Plataspidae inhabited North America, so reports of *M. cribraria* from Georgia were a new United State record and the first known establishment of a species of Plataspidae in the Western Hemisphere. Over the next several weeks, specimen samples were sent in from eight additional north and central Georgia counties. *Megacopta cribraria* detections continued to increase rapidly, and by 2010, the insect was confirmed in dozens of Georgia counties, as well as limited distributions in Alabama, South Carolina, and North Carolina (Gardner et al. 2013b). Detections continued to expand and by 2013, *M. cribraria* had been confirmed in twelve southeastern states (Alabama, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia) and the District of Columbia. *Megacopta cribraria* was first detected in Maryland in five southern counties from mid-June to early July 2013: Anne Arundel, Calvert, Charles, Prince George's, and St. Mary's Counties (Leslie and Lamp 2013a). Two additional counties, Montgomery and Dorchester, were added by the end of August 2013. The Dorchester County detection is the first on the Maryland portion of the Delmarva Peninsula, although it had already been found on both the Delaware and Virginia sections (Leslie and Lamp 2013b).

Initially considered a nuisance pest like its distant cousin, the Brown Marmorated Stink Bug (*Halyomorpha halys* Stål [Hemiptera: Pentatomidae]), Del Pozo-Valdivia and Reisig (2013) showed that first-generation *M. cribraria* were able to feed exclusively on soybeans (*Glycine max* [L.] Merr. [Fabaceae]), reach maturity and reproduce. Until then, it was believed that feeding on kudzu vine was required for successful reproduction (Zhang et al. 2012). *Megacopta cribraria* is now considered a serious economic pest of soybeans that may be able to spread anywhere within the United States that soybeans are grown (Ruberson et al. 2012, Gardner et al. 2013b). With a confirmed rapid spread from nine counties in one state in 2009, to hundreds of counties in 12 states and the District of Columbia in only four years, *M. cribraria* has already established itself as an economic

pest of soybeans in the south, and may pose a threat to other leguminous crops (Fabaceae) (Gardner et al. 2013b).

BIOLOGY AND DESCRIPTION

Megacopta cribraria (Figure 1) belongs to the order Hemiptera in the suborder Heteroptera, the true bugs, and is a member of the infraorder Pentatomomorpha, including stink bugs, shield bugs, and relatives. In its native range in Asia and India, it is reported to have up to three generations annually (Eger et al. 2010), but thus far has produced two generations annually in the southern United States (Zhang et al. 2012). *Megacopta cribraria* overwinters as an adult in cracks and crevices of buildings and structures, in leaf litter, and under the bark of trees located near host plants. In the United States, adults emerge in spring, form large mating aggregations, and begin laying first-generation eggs in April (Zhang et al. 2012), most frequently on kudzu vines (Figure 2). Adults are strong flyers, and there are three peak periods of adult flight activity: early spring (April/May) when overwintering adults first emerge, throughout the summer (June-August) when first-generation adults are active, and then in the fall (October) when second-generation adults mature. It is second generation adults that overwinter (Zhang et al. 2012), but it may be possible that *M. cribraria* can remain active all year in warmer climates (Thippeswamy and Rajagopal 1998, Eger et al. 2010). Both adult and nymphal populations display an edge effect, being found in greater numbers around the perimeters of fields where they are feeding, than in the interiors (Seiter et al. 2013b).

Figure 1. Kudzu Bug, *Megacopta cribraria* (Fabricius) (Hemiptera: Plataspidae), adults. Left: dorsal view; Right: anterodorsal view. (Image credits: Left: William O. Lamp; Right: Bill Johnson, Bill Johnson Nature Stock Photography, Inc. [by permission])

Female *M. cribraria* are reported capable of laying 26 to 274 eggs (Eger et al. 2010) in masses of about 20 eggs each, with a reported range of 16 to 28 per cluster (Zhang et al. 2012, Del Pozo-Valdivia and Reisig 2013, Gardner et al. 2013b), typically deposited in two parallel rows (Figure 3). Egg masses are usually located on new leaf growth in the upper canopy of kudzu, but also on the undersides of leaves and vines of older plants (Eger et al. 2010, Zhang et al. 2012, Seiter et al. 2013c). Females deposit small brown capsules containing the gut symbiotic γ-proteobacterium '*Candidatus* Ishikawaella

Figure 2. Kudzu, *Pueraria montana* (Lour.) Merr. (Fabaceae). Top: close-up; Bottom: vines overwhelming a tree. (Image credits: Alan W. Leslie)

Figure 3. Kudzu Bug eggs on a kudzu leaf. Top: freshly laid; Middle: older, but not yet hatched; Bottom: hatched and unhatched. (Image credits: Top and middle: Alan W. Leslie; Bottom: Bill Johnson)

Figure 4. Kudzu Bug nymphs. Top left, top right, middle left: early to mid-instars; Middle right: 4th or 5th (late) instar; Bottom: various instars on kudzu vine. (Image credits: Top left, top right, middle left: Bill Johnson; Middle right: Michael J. Raupp; Bottom: John Ruberson, Kansas State University, Bugwood.org)

capsulata' beneath each egg mass. The presence and genotype of the bacterial symbiont stored in the gut of the bug appears to play a significant role in determining suitable host plants for normal growth and development of *M. cribraria* (Jenkins et al. 2010, Ruberson et al. 2012). Eggs hatch in about one week and the newly emerged nymphs feed on the symbiotic bacteria, which enables them to survive on host plants such as kudzu, soybeans, peas, beans, and peanuts, and other legumes (Jenkins et al. 2010). Nymphs develop through five instars over a period of 4-6 weeks (Ruberson et al. 2012) (Figure 4). Newly hatched nymphs tend to aggregate near the egg mass, but the second and third instar nymphs begin to disperse from that location (Zhang et al. 2012). Nymphs reportedly cluster together when feeding, and are likely to be found in large numbers feeding around growing points and nodes of host plants (Seiter et al. 2013c). Reported estimates of development time from egg to adult vary widely (24 to 56 days), as do estimates of adult longevity (less than one week up to 11 weeks), depending on location, temperature, and other conditions (Eger et al. 2010, Ruberson et al. 2012, Zhang et al. 2012, Seiter et al. 2013c).

SPREAD

Megacopta cribraria are strong and rapid flyers as well as exceptional hitchhikers. Until 2012, expansion of its range appeared to have primarily been progressively outward movement of the leading edge of the infestation. However, in 2012, *M. cribraria* was detected in western Mississippi, nearly 320 km (198.8 mi) from the known western edge of its range in Alabama at that time. The site in Mississippi was adjacent to an east-west highway running through the states. Weather fronts and strong air currents were likely involved in long-range dispersal of adults to the east and northeast in 2011. Violent thunderstorms and tornadoes that year moved across the southern range of *M. cribraria* up the Mid-Atlantic coast (Ruberson et al. 2012, Gardner et al. 2013b). Adult *M. cribraria* have also been found 32 stories above ground in high-rise buildings in Atlanta, attesting to their flight capability. Other confirmed isolated pockets of infestation in 2012 that occurred in areas well removed from the existing range of *M. cribraria* were likely the result of hitchhiking, prevailing winds, and weather fronts. International trading partners of the United States have become concerned with potential invasion after the discovery by Honduran agricultural port inspectors of several live and dead *M. cribraria* in containerized shipments of blended cotton/polyester yarn from the United States. The shipments were rejected, and future such incidents could significantly impact export opportunities for the United States. The host range of *M. cribraria* will probably continue to expand as they disperse long distances, possibly along transportation routes in the northeastern and western United States (Medal et al. 2013).

IDENTIFICATION

Adults:

- Newly emerged adults are soft and whitish, but harden and darken within several hours
- Small: ~ 4-6 mm (~ 0.16-0.24 in) long and ~ 4.0 mm (~ 0.16 in) wide (similar size to a small lady beetle or pea)

- Squarish shape, wider at the scutellum (the posterior plate along the dorsal side of the thorax) than anteriorly (More common stink bugs have a shield-shaped body with a triangular-shaped scutellum.)
- Scutellum enlarged, covers the forewings and most of the abdomen, truncated with a flattened posterior end (a characteristic unique to this species when compared to other United States stink bugs)
- Mottled brown to olive-green in color; dorsal side covered with numerous, small dark punctures giving a speckled appearance.
- Females with a broad pale area laterally on the abdomen, venter black; males with limited pale area, venter black and hairy
- Emit a pungent odor when disturbed
- Most distinguishing characteristics: size; enlarged and truncated scutellum; 2-segmented tarsi

Eggs:

- Tiny, cylindrical-shaped, with an outward facing operculum ("lid") surrounded by short spiny projections
- White when first laid, turning pale pink/salmon soon after
- Typically laid in two, or occasionally three, parallel rows of about 20 eggs per cluster
- Most commonly found attached to tender leaf sheaths of new growth; also found on undersides of leaves and older growth
- Beneath the eggs are dark capsules containing symbiotic bacteria deposited by females

Nymphs:

- 5 instars, ranging from 1st instar at ~ 1 mm (~ 0.04 in) up to 5th instar ~ 4-5 mm (~ 0.16-0.20 in) in length; somewhat flattened; very hairy; color ranges from pale orange to green to brown
- 1st instars are reddish, soon turn light brown; aggregate near egg masses
- 2nd and 3rd instars are yellowish-green and disperse from the vicinity of egg masses
- 4th and 5th instars are greenish to greenish/brown with well-defined wing buds

HOST PLANTS

In its native range in Asia, *M. cribraria* is most commonly reported feeding on legumes (Fabaceae) such as kudzu, *Pueraria* DC. spp.; hyacinthbean, *Lablab purpureus* (L.) Sweet; dunchi fiber, *Sesbania bispinosa* (Jacq.) W. Wight; black gram, *Vigna mungo* (L.) Hepper; mung bean, *Vigna radiata* (L.) R. Wilczek; and soybean, as well as many other beans and peas, lespedeza, *Lespedeza* Michx. spp.; vetch, *Vicia* L. spp.; and wisteria, *Wisteria* Nutt. spp. (Eger et al. 2010). Additionally, in China it has been reported feeding on fruit trees including peach, *Prunus persica* (L.) Batsch (Rosaceae); plums, *Prunus* L. spp.; and jujube, *Ziziphus jujuba* Mill. (Rhamnaceae) (Wang et al. 1996, Li et al. 2001, Wang et al. 2004). An expanded list of Asian hosts compiled by Eger et al. (2010) reported more than 30 herbaceous and woody hosts used by *M. cribraria* and its closely related congener *M. punctatissima* (Montandon). Few reports of *M. cribraria* on non-leguminous hosts are given by more than one author and only adults were reported, so

they possibly do not survive and reproduce on these plants (Eger et al. 2010). Two exceptions to this observation are the non-legumes firecracker flower, *Crossandra infundibuliformis* (L.) Nees (Acanthaceae) and upland cotton, *Gossypium hirsutum* L. (Malvaceae), on which Srinivasaperumal et al. (1992) reported *M. cribraria* survived and reproduced, although female fecundity was lower and nymphs took longer to develop than on the leguminous host vegetable hummingbird, *Sesbania grandiflora* (L.) Poir.

In the United States, *M. cribraria* feeds primarily on kudzu, which was introduced from Japan and widely planted for erosion control throughout the South over the last century, but is now considered one of the most serious invasive plants in this nation (Zhang et al. 2012). However, *M. cribraria* has also become a serious pest on soybeans in several southern states where it has become established (Ruberson et al. 2012). It is believed that other legumes could join the list of host plants. Zhang et al. (2012) identified ten common forest legumes found in North America that supported survival of adult *M. cribraria*. These included: Kentucky yellowwood, *Cladrastis kentukea* (Dum. Cours.) Rudd; sericea lespedeza, *Lespedeza cuneata* (Dum. Cours.) G. Don; kudzu, *Pueraria montana* (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida; hairy lespedeza, *Lespedeza hirta* (L.) Hornem.; silktree, *Albizia julibrissin* Durazz.; redcardinal, *Erythrina herbacea* L.; black locust, *Robinia pseudoacacia* L.; hyacinthbean; eastern redbud, *Cercis canadensis* L.; and blue wild indigo, *Baptisia australis* (L.) R. Br. Although egg-laying occurred on many of these potential hosts, adults only developed from eggs deposited on kudzu and soybeans. Gardner et al. (2013b) surveyed 33 plants species for potential host range of *M. cribraria* and identified another 16 plants not reported by Eger et al. (2010) or Zhang et al. (2012) on which the insect was observed. However, all life stages (eggs, nymphs, and adults) of *M. cribraria* were recorded on only two species – kudzu and soybean – the only confirmed reproductive hosts of *M. cribraria* in the United States to date. Medal et al. (2013) demonstrated in a no-choice caged feeding test that *M. cribraria* was able to develop reproductively on several leguminous crops. Best development occurred on kudzu and soybean (no significant difference), followed by pigeonpea, *Cajanus cajan* (L.) Millsp., then at significantly lower values on kidney bean, *Phaseolus vulgaris* L., Sieva bean, *Phaseolus lunatus* L., and cowpea, *Vigna unguiculata* (L.) Walp., indicating that *M. cribraria* may be able to expand its known reproductive host range in North America.

FEEDING DAMAGE and IMPACT

Megacopta cribraria is a piercing-sucking insect, and it removes sap from the vascular tissue of stems, petioles, leaves, and fruit of a wide variety of plants. Plant injury noted on soybeans in Asia includes leaf discoloration, deformation of fruiting structures such as pods, and reduction in seed size (Xing et al. 2006). *Megacopta cribraria* also produces honeydew, thereby providing a substrate for the growth of sooty mold that is thought to reduce photosynthesis (Xing et al. 2006, Zhang et al. 2012). A greenhouse study revealed that high densities of *M. cribraria* reduced yields and quality of field beans grown in pots (Thippeswamy and Rajagopal 1998). Thippeswamy and Rajagopal (2005) also reported that although *M. cribraria* will feed on leaves, stems, flowers, and pods of soybeans, they prefer tender new growth to older growth. They noted that white patches developed at feeding sites, and eventually turned brownish and coalesced into necrotic

areas. Shoots withered with heavy infestations and bean pods did not develop normally. Feeding on soybeans in the United States has led to reported reductions in crop yields of 1-50% (Wang et al. 1996), and nearly 60% in soybean field-cage experiments (Seiter et al. 2013b), indicating the potential for this bug to become a significant pest of soybean.

PEST STATUS

Megacopta cribraria is considered an urban nuisance as well as a significant agricultural pest. The insect was first reported by worried homeowners who found thousands of bugs aggregating on the sides of their homes in autumn. The pest is particularly attracted to white and light-colored surfaces, vehicles, and structures, and may be more commonly found on sunlit southern and eastern exposures of buildings (Horn and Hanula 2011). When handled, adults can produce an offensive odor, and both adults and nymphs may produce a yellow stain when crushed. Nymphs in particular may cause a rash or welts on the skin of sensitive individuals (Ruberson et al. 2012).

THE SPREAD OF *M. CRIBRARIA* IN MARYLAND

It was anticipated that *M. cribraria* would appear in Maryland during the spring and summer of 2013. In 2012, the distribution of *M. cribraria* in its introduced range had reached as far north as central Virginia, and projections of the expansion of the insect's range for 2013 placed it within Maryland (Ruberson et al. 2012). Concerned that *M. cribraria* could become a pest of Maryland agriculture, the University of Maryland (UMD) Lamp Entomology Lab initiated a two-part survey to provide for early detection of the pest within state borders, and to determine the geographical extent of its spread within the state. We sampled kudzu across the state, and established the Maryland Kudzu Bug Survey website (http://mdkudzubug.org/) to enlist the public's aid in monitoring and reporting both suspected detections of *M. cribraria* and the locations of kudzu patches growing within the state. Independently, entomologists with the Smithsonian Institution, the United States National Park Service, the United States Army, and the United States Department of Agriculture - Agricultural Research Service also conducted examinations of kudzu patches in Maryland and the District of Columbia, which led to additional detections and records that have been combined with those of UMD for this report.

METHODS

Forty-five kudzu patches were sampled across nine Maryland counties and the District of Columbia from June to October 2013 (Figure 5). UMD researchers gave particular emphasis to sampling kudzu patches within southern counties, as we believed the insect would appear there first, as it moved north from neighboring Virginia. Sampling was done by visually inspecting leaves and vines for insects and their egg masses, as well as by beating vines with handheld nets. Specimens were either preserved in 85% ethanol or frozen before being pinned or mounted on points.

We also wanted to monitor whether the insect would switch from its primary host of kudzu to feeding and reproducing on soybeans. To do this, we planted and monitored

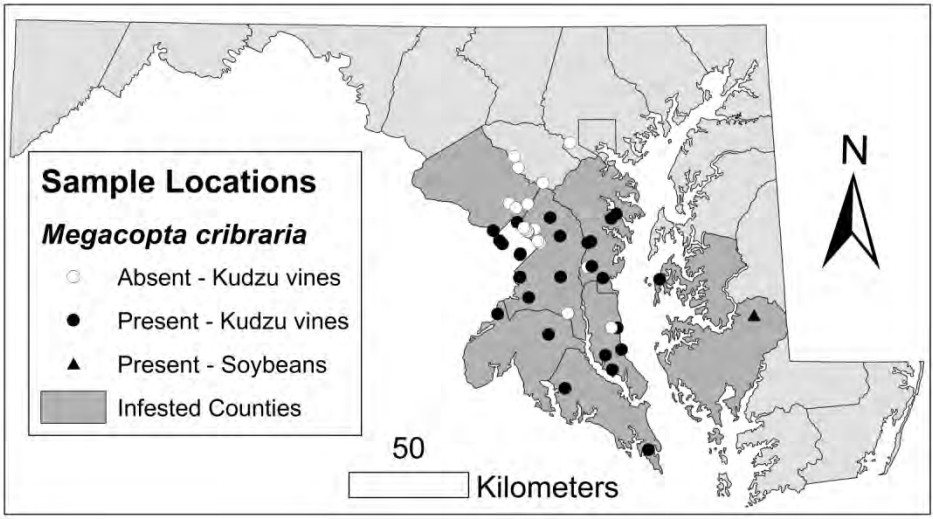

Figure 5. Map of *M. cribraria* sampling sites in Maryland and the District of Columbia, 2013. Forty-five kudzu patches were sampled for *M. cribraria* (indicated by white and black circles). Twenty-eight kudzu patches contained *M. cribraria* (indicated by black circles) across seven counties, plus the District of Columbia. At this scale, pairs of points showing distinct patches with kudzu bugs are overlapping in Montgomery and Prince George's Counties, and the District of Columbia. *Megacopta cribraria* was also reported from a single soybean field in Dorchester County.

edible soybeans (edamame var. Midori Giant), which are a variety of soybean that is particularly attractive to *M. cribraria*. Edamame soybeans were planted at five University of Maryland research farms (Research & Education Centers [REC]): Western Maryland REC (Keedysville, Washington County), Central Maryland REC-Beltsville (Prince George's County), Central Maryland REC-Upper Marlboro (Prince George's County), Wye REC (Queenstown, Queen Anne's County), Lower Eastern Shore REC (Salisbury, Wicomico County) and one plot in St. Mary's County through cooperation with the county extension office. Edamame soybean plants were sampled throughout the summer visually and by sweeping with handheld nets. In addition, we sampled any other soybean plants adjacent to these plots, as well as soybean fields adjacent to kudzu patches that were sampled. We also coordinated our efforts to monitor for *M. cribraria* with other UMD researchers sampling soybean fields for insect pests.

Finally, as Maryland is the new northern limit of the spread of this insect, we sought to determine whether the insects would be able to successfully overwinter as adults and persist in the following year, or if the colder climate would increase mortality and therefore keep populations low the following year. To do this, we examined overwintering sites adjacent to kudzu patches in search of dormant adults, following the senescence of kudzu vines and the onset of cold weather. Later in November,

examination of kudzu patches in Maryland and the District of Columbia led to additional records, followed by more collections and observations of bugs in hibernation.

RESULTS

The earliest recorded individuals were collected on 11 June 2013 from a kudzu patch in Anne Arundel County. By the end of summer, *M. cribraria* had been detected within 28 kudzu patches across seven Maryland counties, plus the District of Columbia. Some kudzu patches sampled earlier in the season did not have *M. cribraria*, but became colonized by the insect later in the summer. Populations within the re-sampled sites increased through the summer. A single dispersing adult was detected at the Beltsville Agricultural Research Center, Prince George's County, away from kudzu vines on 20 August 2013. Total individuals collected per site ranged from one to 48, and the mean sex ratio among adults was significantly skewed towards males at 1.28:1 (male:female, $\chi 2 = 4.24$, df = 1, P = 0.04), supporting earlier observations by Zhang et al. (2012) and Seiter et al. (2013c) of an overall sex bias towards males.

No life stages of *M. cribraria* were detected in soybeans over the summer through our sampling. One record of the insect on soybeans was submitted to us by a crop consultant, who found two adult insects in a soybean field in Hurlock, Maryland (Dorchester County). We calculated the distance from each kudzu patch sampled to the nearest fields used for soybean production using ArcGIS (Esri, Redlands, California) and USGS land use and land cover dataset (USDA-NASS 2013) (Figure 6). We compared the mean distance to the nearest soybean field for kudzu patches with and without *M. cribraria* using a t-test after log (x+1) transforming distances to satisfy assumptions of normal distribution. Kudzu patches from the District of Columbia were excluded from the analysis. This analysis showed that on average, kudzu vines infested with *M. cribraria* were closer to soybean fields than kudzu vines that did not have *M. cribraria* present (t = 1.99, df = 38.8, P = 0.054).

By the end of 2013, *M. cribraria* had been confirmed in eight Maryland counties, plus the District of Columbia (Figure 5). We noted the Davidsonville site (Anne Arundel County) had by far the largest kudzu infestation and *M. cribraria* were very abundant on 14 October 2013, with several hundred bugs easily observed. Examination of potential hibernation sites on 1 January 2014 proved positive, with bugs hiding under leaf litter in depressions at the base of an isolated oak (*Quercus* L. sp.[Fagaceae]), and under bark of a dead standing pine (*Pinus* L. sp. [Pinaceae]), not far from kudzu vines. One month later, however, after two severe hard freezing events (6-8 January 2014 and 22-24 January 2014, lows -12 to -15°C [10 to 5°F]) all 20 of the bugs collected at the base of the oak were found dead. At the Sherwood (Talbot County) site, only one of four overwintering bugs was found alive after the hard freezes. No live bugs (four fragmented cadavers) were found at the Oxon Hill (Prince George's County) site, though it was difficult to locate suitable hibernation sites where bugs may have concentrated. We suspect that if bugs located themselves in deep crevices and under cover, winter survival would be possible.

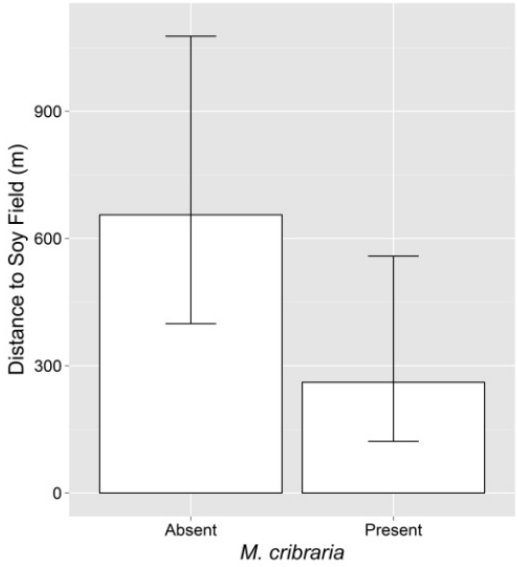

Figure 6. The mean distance from kudzu patches sampled to the nearest soybean field. Kudzu patches with *M. cribraria* (N = 28) were significantly closer to soybean fields than patches that did not have *M. cribraria* (N = 17). Error bars show 95% confidence interval.

We review these occurrences and use specimen label data to substantiate records of this newly arrived invasive insect. Specimens are deposited in the United States National Museum of Natural History, Smithsonian Institution, Washington, D.C., the collection of the Maryland Department of Agriculture, Annapolis, and the insect museum of the Department of Entomology at the University of Maryland, College Park. Where available, specimen label data below are quoted verbatim, with commas inserted for clarity; breaks between labels are separated by a backslash. The number of specimens bearing those data follow in parentheses; A = adult (unsexed); M = male; F = female; N = nymph.

District of Columbia Records

"DISTRICT OF COLUMBIA: NW Washington, Palisades area near Fletcher's Cove, 38°55'01"N, 77°05'55"W, 28 July 2013 \ On foliage of *Pueraria* at roadside; colls. W. E. Steiner & J. M. Swearingen" (1F); "DISTRICT OF COLUMBIA: SE Washington, Anacostia Park, 38°52'05"N, 76°59'50"W, 7 September 2013 \ Beaten from foliage and vines of *Pueraria* at open roadside; colls. W. E. Steiner & J. M. Swearingen" (3M, 8F); "DISTRICT OF COLUMBIA: SE Washington, Hillsdale area along Howard Road, 38°51'52"N, 76°59'53"W, 28 July 2013 \ On foliage and vines of *Pueraria* at roadside; colls. W. E. Steiner & J. M. Swearingen" (3M, 2F); District of Columbia, report from D. Weber: 38°54'19"N, 77° 05'02"W, 19 Aug 2013: Light infestation of kudzu bug on

riverside patch of kudzu; adults only observed, along with brown marmorated stink bug. Kudzu which is long-established on riverside mostly on southwest side of Capital Crescent Bike-Hike trail just south and west of C&O Canal, on NPS land. Just upstream of Three Sisters (islands) in Potomac River. Kudzu is now overgrown in places with porcelain vine and feral hop vines. In other areas it is still thriving and in full bloom.

Maryland Records Listed by County

Anne Arundel County: "MD: Anne Arundel Co., AA-2 Mt. Zion Marlboro Rd, on *Pueraria montana*, 38.820992, -76.649826, 11-Jun-2013, A. Leslie & V. Johnson" (2A, 9M, 2F, 1 egg cluster); "MD: Anne Arundel Co., AA-2 Mt. Zion Marlboro Rd, on *Pueraria montana*, 38.820992, -76.649826, 1-Jul-2013, A. Leslie & V. Johnson" (1M, 2F); "MD: Anne Arundel Co., AA-3 Rt 2, on *Pueraria montana*, 38.775990, -76.596191, 1-Jul-2013, A. Leslie & V. Johnson" (1A); "MD: Anne Arundel Co., AA-4 MD 214 at Patuxent River, on *Pueraria montana*, 38.908596, -76.669449, 15-Aug-2013, A. Leslie & V. Johnson" (2M, 2F); "MD: Anne Arundel Co., AA-5 Epping Forest Rd, on *Pueraria montana*, 39.000404, -76.554153, 15-Aug-2013, A. Leslie & V. Johnson" (4M, 1F); "MARYLAND: A. Ardl. Co., Annapolis, at Epping Forest Clubhouse on Severn River, 39°01'0"N, 76°31'44"W, 2 November 2013 \ On *Pueraria* vines at forest edge; B. B. Pagac, W. E. Steiner, J. M. Swearingen, et al. collectors" (11M, 9F); "MARYLAND: Anne Arundel County, 2 km WSW Davidsonville, 38°54'50"N, 76°39'13"W, 14 October 2013, on *Pueraria*, roadside \ Colls. G. L. Williams, W. E. Steiner, J. M. Swearingen, E. L. Nakash, W. M. Johnson, R. H. Dabill" (17M, 10F, 20N, 2 egg clusters); same data except "38°54'49.5"N, 76°39'15"W, 1 January 2014 \ Under leaf litter at base of pin oak, open turf area; Colls. W. E. Steiner & J. M. Swearingen" (19M, 14F); same data except "38°54'48"N, 76°39'13"W \ Under loose bark of dead standing loblolly (*Pinus taeda*) in edge of mixed forest tract" (2M, 5F); same data except "38°54'49.5"N, 76°39'15"W, 1 February 2014, Under leaf litter at base of pin oak, open turf area (specimen found dead) \ W. E. Steiner, J. M. Swearingen, E. L. Nakash Collectors" (13M, 7F); MARYLAND: A.Ardl. Co., Annapolis, at Epping Forest Road X Old Epping Forest Road 39°0'12.672"N, 76°33'7.923"W, 7 November 2013, On *Pueraria* vines, at Roadside, B. B. Pagac (1M, 1F, 1N).

Calvert County:"MD: Calvert Co., CA-1 Gray's Rd, on *Pueraria montana*, 38.486931, -76.585854, 1-Jul-2013, A. Leslie & V. Johnson" (2M, 3F); "MD: Calvert Co., CA-2 Broomes Island Rd, on *Pueraria montana*, 38.432125, -76.552147, 1-Jul-2013, A. Leslie & V. Johnson" (1M, 0F); "MD: Calvert Co., CA-3 Wilson Rd & Dunn Rd, on *Pueraria montana*, 38.432125, -76.552147, 1-Jul-2013, A. Leslie & V. Johnson" (1M, 3F, 1 egg cluster); "MARYLAND: Calvert Co., Scientists Cliffs, 38°30'29"N, 76°30'27"W, 4 August 2013 \ Swept from foliage and vines of *Pueraria* above sand beach; colls. W. E. Steiner, J. M. Swearingen, B. S. & S. E. Dixon" (11M, 2F, 6N).

Charles County: "MD: Charles Co., CH-1 Fenwick Rd, on *Pueraria montana*, 38.64190, -77.10698, 3-Jul-2013, A. Leslie & V. Johnson" (1F); "MD: Charles Co.,

CH-2 Rt 5/ LaPlata Rd, on *Pueraria montana*, 38.564766, -76.859825, 3-Jul-2013, A. Leslie & V. Johnson" (1A, 4F).

Dorchester County: "MD: Dorchester Co., DO-1 Soybeans, on *Glycine max*, Hurlock, MD, 20-Aug-2013, L. McConnell" (1M, 1F).

Montgomery County: "MARYLAND: Montg. Co., SE of Glen Echo, 38°57'15"N, 77°07'42"W, 27 July 2013 \ On foliage and vines *Pueraria* at roadside; colls. W. E. Steiner & J. M. Swearingen" (1M, 6F); same data except "2 November 2013 \ On foliage and vines *Pueraria* at roadside; colls. W. E. Steiner, J. M. Swearingen, S. I. Morita" (11M, 5F, 8N); "MARYLAND: Montg. Co., Takoma Park, 38°59'12"N, 77°0'42"W, 28 July 2013 \ Beaten from foliage *Pueraria* at edge of open field; colls. W. E. Steiner & J. M. Swearingen" (1M, 1F); same data except "16 August 2013 \ coll. W. E. Steiner" (2M, 5F); same data except "13 October 2013 \ Beaten from foliage *Pueraria* at edge of open field; colls. W. E. Steiner, J. M. Swearingen, W. M. Johnson, R. H. Dabill" (2M, 1F, 1N); Montgomery Co. MD report from D. Weber: 38°57'16"N 77°07'42"W, 19 August 2013: Light infestation of kudzu bug with adults mainly on leaf axils and one nymph observed on large patch of kudzu on south side of MacArthur Boulevard. Large patch of kudzu between MacArthur Boulevard and Clara Barton Parkway (NPS land near Chesapeake & Ohio Canal National Historic Park), near Brookmont section, Cabin John, Montgomery Co. MD. Established patch growing over tall trees.

Prince George's County: "MD: Prince George's Co., PG-8 Danville Rd & Floral Park Rd, on *Pueraria montana*, 38.704197, -76.956207, 1-Jul-2013, A. Leslie & V. Johnson" (1A, 2M, 1F); "MD: Prince George's Co., PG-2 210/Livingston Rd, on *Pueraria montana*, 38.780685, -76.998177, 3-Jul-2013, A. Leslie & V. Johnson" (1M); "MD: Prince George's Co., PG-4 USDA field Hubble Dr, on *Pueraria montana*, 39.003872, -76.851456, 6-Aug-2013, A. Leslie & V. Johnson" (2M, 1F); "MD: Prince George's Co., PG-1 Rosaryville St. Pk., on *Pueraria montana*, 38.781174, -76.802147, 15-Aug-2013, A. Leslie & V. Johnson" (3M, 4F); "MD: Prince George's Co., PG-13 Rt 193 and Locust Dale Dr, on *Pueraria montana*, 39.934299, -76.803947, 15-Aug-2013, A. Leslie & V. Johnson" (6M, 6F); "Prince George's Co. MD: Beltsville, 39°01'37.35"N 76°55'41.26"W, Single flying bug near greenhouse near 3rd Drive, USDA ARS Beltsville Agricultural Research Center. G. Cabrera Walsh [collector], 20 Aug 2013" (1A); "MD: Prince George's Co., PG-4 USDA field Hubble Dr, on *Pueraria montana*, 39.003872, -76.851456, 21-Aug-2013, A. Leslie & V. Johnson" (1M, 1F); "MARYLAND: Pr. Geo. Co., Oxon Hill, 38°46'48"N, 76°59'54"W, 7 September 2013 \ Swept from foliage and vines of *Pueraria* along creek channel; Colls. W. E. Steiner & J. M. Swearingen" (9M, 4F); same data except "2 February 2014 \ On ground under matted leaf litter and vines of *Pueraria* on bank along creek channel (specimens found dead) \ W. E. Steiner, J. M. Swearingen, E. L. Nakash Collectors" (2M, 2F in gelatin capsule); Prince Georges Co. MD, report from D. Weber: 39°00'16"N 76°05'07"W 16 August 2013: W of intersection of Soil Conservation Road and Hubble Road. Large kudzu patch SW of soybean field. Several patches of light infestation with a few nymphs.

Saint Mary's County: "MD: Saint Mary's Co., StM-1 St. Peter Clavers Rd, on *Pueraria montana*, 38.131466, -76.379257, 3-Jul-2013, A. Leslie & V. Johnson" (1A, 3M, 4F, 2N); "MD: Saint Mary's Co., StM-2 Hurry Rd, on *Pueraria montana*, 38.3630229 N, -76.7807563 W, 23-Aug-2013, A. Leslie & V. Johnson" (2M, 5F).

Talbot County: "MARYLAND: Talbot Co., Sherwood, 38°46'13"N, 76°19'14"W, 18 August 2013, Swept from foliage of *Pueraria* at roadside; colls. W. E. Steiner & J. M. Swearingen" (3M, 1F); same data except "27 September 2013" (6M, 2F, 40N); same data except "12 October 2013 \ colls. W. E. Steiner, J. M. Swearingen, W. M. Johnson, R. H. Dabill" (8M, 10F, 12N); same data except "1 February 2014 \ On ground under matted leaf litter and *Plantago* rosette, edge of patch *Pueraria* at roadside \ W. E. Steiner, J. M. Swearingen, E. L. Nakash collectors" (1M); same data except "(specimen found dead)" (3M).

DISCUSSION

Our surveys have documented the first instances of *M. cribraria* in Maryland, and have tracked its spread through the summer of 2013. Bugs were found at 28 of 45 of the sampled patches of kudzu vines, and seemed to be more abundant in southern counties. *Megacopta cribraria* was not found north of Annapolis, indicating the current northern limit of the invasion. South of this apparent border, there were many sites that never had any *M. cribraria*, which may reflect its recent arrival. Kudzu patches that did have *M. cribraria* were significantly closer to soybean fields than patches that did not have *M. cribraria*, which may indicate that *M. cribraria* may favorably colonize kudzu vine patches in more rural areas. This effect may be mediated by the availability of other host plants within the rural landscape that the insect can feed on, such as wisteria and redbud. Kudzu patches in more urban areas may also be subject to active eradication efforts to avoid encroachment onto private property, and therefore may be smaller. Patch size was not a factor that was measured during this survey, but may be considered in the future. Identifying dispersal limits of the insect may be useful for predicting the northern limits of its spread, especially as it enters landscapes where kudzu vines are less prevalent.

There were no reports of *M. cribraria* causing damage to soybean crops in Maryland in 2013, possibly because of low densities as it becomes established in the state. In Georgia, *M. cribraria* was detected moving into soybean fields from the end of June through mid-July, and nymphs typically appeared at the sensitive pod-filling stages (Suiter et al. 2010). We did not see high abundances of *M. cribraria* on kudzu vines until late summer and early fall, which may have precluded the insects from moving onto soybeans. The usual harvest time for soybeans in Maryland is mid-October to mid-November, which puts the dates of peak abundance of *M. cribraria* in 2013 outside of the growing season for Maryland soybeans, as soybean plants were already senescing at this time (USDA-NASS 2010). If this pattern of abundance continues into following years, the population of insects on kudzu vines may never build up to levels that would spill over into soybeans. However, if populations increase faster in future years as a result of previous establishment in Maryland, *M. cribraria* may build up on kudzu vines earlier and begin to disperse into soybeans during sensitive growth stages.

Since first being detected in 2009, *M. cribraria* has continued to increase its range northward every year (Ruberson et al. 2012). For 2014, we expect *M. cribraria* to continue its spread throughout Maryland east of the Blue Ridge Mountains, and possibly cross the Pennsylvania border. Winter mortality may play a role in the continued spread of the insect throughout Maryland, and preliminary observations of overwintering sites suggest that for winter 2013-14, survival may be low. Further surveys for the emerging adult insects will be needed for the coming spring 2014 to accurately assess persistence of adult insects through the overwintering stage. Few kudzu vine patches were discovered on Maryland's Eastern Shore, which made surveying for the insect in 2013 difficult. The most efficient way of detecting the insect on the Eastern Shore may be through education of farmers and crop consultants to recognize the new invasive species, and to report sightings to researchers.

It is currently unclear whether *M. cribraria* will become an established pest of soybean crops in Maryland. However, the status of *M. cribraria* as a potential pest of soybeans and other legumes in Maryland needs to be monitored, and future research on this insect in Maryland should focus on the timing of development and number of generations produced within Maryland's climate, and possible interactions with other pests of soybeans. The phenology of kudzu vines and the planting schedule for soybeans may differ enough from the southern range to prohibit multiple generations of the insect from developing within a single year. Now that populations of the insect have been located in Maryland, demographic studies can be conducted to determine timing of generations on the kudzu vine host. If *M. cribraria* does become a pest of soybeans in Maryland, it may interact with another invasive insect pest, the Brown Marmorated Stink Bug, which has also become established in Maryland. Future studies may determine whether there are any interactions between the combined feeding of the two insects on soybean plants, and how timing of movement into soybean fields may differ between the two species.

CONTROL/MANAGEMENT

Mechanical/Physical Control:
There are no confirmed reports of *M. cribraria* invading buildings in Maryland to date. To reduce the likelihood of invasion, host plant material, such as kudzu or wisteria, growing near buildings may be removed or cut back. However, *M. cribraria* may readily fly over from host plants growing near, but not on, the affected property. Should they become a problem in or on homes, physical barriers such as caulking openings or cracks and screening over larger openings to prevent entry is preferable to using chemical pesticides indoors. See Sargent et al. (2011) for a full description of mechanical/physical control methods for excluding invasive Brown Marmorated Stink Bugs from homes, which will work as well for *M. cribraria*.

Biological Control:
In its native range, predators of *M. cribraria* include an unidentified assassin bug (Hemiptera: Reduviidae) (Ahmad and Moizuddin 1976); *Oxyopes shweta* Tikader (Araneae: Oxyopidae) – a lynx spider; and *Antilochus coqueberti* (Fabricius) (Hemiptera: Pyrrhocoridae) (Borah and Sarma 2009) – a red bug. In the invaded range in North America, predators of *M. cribraria* include *Geocoris uliginosus* (Say) (Hemiptera:

Geocoridae) – a big-eyed bug; *Zelus* Fabricius spp. and *Sinea* Amyot & Serville spp. (Hemiptera: Reduviidae) – both assassin bugs; *Nabis roseipennis* (Reuter) (Hemiptera: Nabidae) – a damsel bug; *Hippodamia convergens* Guérin-Méneville (Coleoptera: Coccinellidae) – Convergent Lady Beetle; *Chrysoperla rufilabris* (Burmeister) (Neuroptera: Chrysopidae) – a green lacewing; *Euthyrhynchus floridanus* (Linnaeus) (Hemiptera: Pentatomidae) – a stink bug (Ruberson et al. 2012); and in 2013, an adult *M. cribraria* was observed and photographed being devoured by a crab spider, *Xysticus* C. L. Koch sp. (Araneae: Thomisidae), in Anne Arundel County, Maryland (Figure 7).

Figure 7. Natural predator. *M. cribraria* being devoured by a crab spider, *Xysticus* C. L. Koch sp. (Araneae: Thomisidae). (Image credit: Bill Johnson)

Throughout its native range in Asia, *M. cribraria* is attacked by several species of parasitoid wasps (Hymenoptera: Platygastridae and Encyrtidae) and rates of egg parasitism can exceed 75% (Ruberson et al. 2012). The platygastrid, *Paratelenomus saccharalis* (Dodd) was under consideration for importation and release in the United States owing to its specificity, broad geographic distribution, and well-known biology (Ruberson et al. 2012). However, the recent discovery of *P. saccharalis* in Georgia likely has obviated this plan (Gardner et al. 2013a). In Georgia, the generalist *Phasia robertsonii* (Townsend) (Diptera: Tachinidae) was reared from a single specimen of *M. cribraria*. Golec et al. (2013) discovered the larvae of another tachinid fly, *Strongygaster triangulifera* (Loew), developing in the abdomen near the reproductive structures of adult male and female *M. cribraria* that had been field collected in Alabama. The larvae caused tissue damage proximate to the reproductive structures in both sexes. The fungal entomopathogen *Beauveria bassiana* (Bals. -Criv.) Vuill. (Cordycipitaceae) has been observed infecting and killing *M. cribraria* in both Asia and North America (Borah and Sarma 2009, Eger et al. 2010, Ruberson et al. 2012). Developing biological control options as part of an overall management program for *M. cribraria* appears promising at this time.

Chemical Control:
A number of pesticides, including pyrethroids, pyrethroid-neonicotinoid mixes, dinotefuran, and indoxacarb, have proven effective in controlling fall aggregations of *M. cribraria* adults when applied to exterior building surfaces (Seiter et al. 2013a). The material chosen should be labeled for structural use, and application should be made when it is sunny and cool, before the bugs become active. Rain and direct sunlight will degrade the chemicals, so reapplication may be necessary if an infestation is severe. These bugs generally do not enter homes and the decision to apply insecticide should be carefully weighed.

The current scouting recommendations for Kudzu Bugs in Georgia, South Carolina, and North Carolina is to use a 38 cm (15 in) diameter sweep net to sample the entire field (minimum 100 sweeps), with a treatment threshold of an average of a single immature insect per sweep. Research conducted in 2010 and 2011 in Georgia and South Carolina for insecticide efficacy on soybeans for control of *M. cribraria* may be accessed on the kudzubug.org website at http://www.kudzubug.org/grower.html (UG-CISEH 2014).

Monitoring/Reporting:
The goal of the Maryland Kudzu Bug Survey is to provide early detection of *M. cribraria* in Maryland and to help farmers and homeowners prepare for this potential pest. The public is asked to help by accessing the website at www.mdkudzubug.org to report:

- The location of any kudzu patches growing in Maryland and associated *M. cribraria*
- Suspected *M. cribraria* in soybeans
- Large aggregations of *M. cribraria* on the sides of structures in the fall before overwintering

Visit the UMD website for updates on our research in Maryland, and for more information on *M. cribraria* in the southern United States, visit www.kudzubug.org.

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New Collection Records of *Rhyssemus scaber* Haldeman (Coleoptera: Scarabaeidae) from Maryland and Virginia

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This note reports four occurrences of a small, infrequently collected scarab, *Rhyssemus scaber* Haldeman (Coleoptera: Scarabaeidae) in Maryland and three new records in Virginia. Neither are new state records but the localities help to fill in the expected distribution in the Delmarva region and define habitat specificities of the beetle. A single listing for Baltimore (Gordon and Cartwright 1980) was the only Maryland record reported previously. In the same paper was a record from Fort Monroe, Hampton, Virginia. No new collections of this beetle have been reported since my note on its habitats and distribution, with records from North Carolina (Ocracoke Island, Hyde County) and Virginia (Parramore Island, Accomack County) (Steiner 1980). No South Carolina specimens are known, but Harpootlian (2001) diagnosed and illustrated the beetle in the treatment of Scarabaeidae for that state, as did Woodruff (1973) with some discussion of a questionable Florida record. A member of the subfamily Aphodiinae, beetles are small (3.3-3.6 mm [0.13-0.14 in] long) with distinct sculpturing on dorsal surfaces (Figure 1 a-b), a row of golden paddle-shaped setae around the pronotal margins, and a pair of "pygidial hairs" (Figure 1c), a character unique to this species.

Specimens are deposited in the United States National Museum of Natural History, Smithsonian Institution, Washington, DC. Specimen label data below are quoted verbatim, with commas inserted for clarity; breaks between labels are separated by a forward slash. Information from field notes is added in brackets. The numbers of specimens bearing the same data follow in parentheses.

Maryland Records

"MARYLAND: Charles Co., Blossom Point, 38°25'N, 77°06'W, 18 October 1995, W. E. Steiner & W. T. Reynolds" (1)

"MARYLAND: Talbot Co., Claiborne; small beach at marina, 38°48'04"N, 76°16'08"W, 29 August 2013 / In sand under matted dead grass and leaf litter at upper beach crest, shrub zone; Coll. W. E. Steiner" (7)

"MARYLAND: Worcester Co., Assateague Island, 22 May 1982, [W. E.] Steiner & [V. A.] Krischik" ["Back of dunes in patchy shrub zone—good series *Rhyssemus* under old horse dung on sand in low flat area; others under leaf litter + pieces of wood…a few more *Rhyssemus* under board by shore—damp sand just above drift line"] (31)

"MARYLAND: Worcester Co., North Ocean City, 38°23'36"N, 75°04'07"W, 10 September 2000, Coll. W. E. Steiner / On damp sand under drift line debris on small

beach at salt marsh edge" (6) ; same data except "1 August 2002 / W. E. Steiner, J. M. Swearingen, M. J. & R. Molineaux collectors" (4)

Virginia Records

"VIRGINIA: Accomack Co., Assateague I. near Chincoteague, 6-7 May 1989, W. E. Steiner & S. M. Fondriest" ["Back in damp grassy slack area under matted dead grass on sand"] (2)

"VIRGINIA: Accomack Co., Chincoteague, 37°56'02"N, 75°22'15"W, 14 January 2001 / In moist sand at drift line on small beach of back bay / W. E. Steiner, J. M. Swearingen, D. E. Beck collectors" (1)

"VIRGINIA, Northampton Co., Hog Is., W. side, 12-13 Oct. 1988, J. M. Hill" (1)

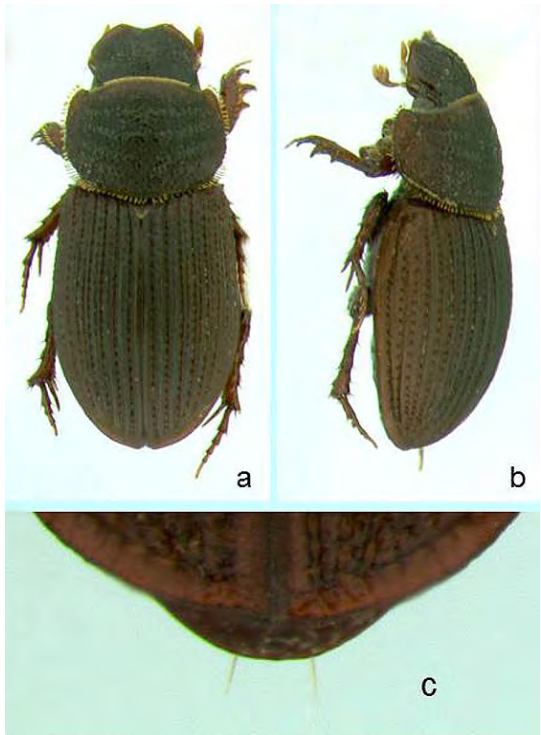

Figure 1. *Rhyssemus scaber* Haldeman (Coleoptera: Scarabaeidae). (a) Dorsal and (b) lateral views; (c) close-up of pygidial hairs at abdominal apex.

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Collection Records of the Crypticine Darkling Beetles (Coleoptera: Tenebrionidae: Crypticini, *Gondwanocrypticus* Español) from the Chesapeake Bay Region

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ABSTRACT: Two species of the tribe Crypticini (Coleoptera: Tenebrionidae, *Gondwanocrypticus* Español) occur in Maryland and adjacent states where they reach the northern limits of their known range. The native *Gondwanocrypticus obsoletus* (Say) is diagnosed and separated from the adventive *G. platensis* (Fairmaire) and specimen data are presented for collections from the Chesapeake Bay region with records from Delaware, Maryland, Virginia, and West Virginia. Their sandy soil habitats and associations with ants are discussed.

INTRODUCTION

The North American members of the tribe Crypticini (Coleoptera: Tenebrionidae) are under review (Steiner 2010) and two species of the genus *Gondwanocrypticus* Español occur in Maryland (Steiner 2008) and adjacent states, as reported here. Crypticines are small, fast-running, oval beetles living under leaf litter on loose soils, and do not get much attention from many collectors. The study of occurrences in North America offers a curious detective story.

After many years of collecting and examining hundreds of museum specimens of this genus, it was apparent that beetles identified as *Gondwanocrypticus obsoletus* (Say), the only species of the genus known from North America at the time (Kulzer 1961; Peck and Thomas 1998 and earlier lists) were a mixture of three distinct species. The native *G. obsoletus* has since been confidently separated from the two others, *G. platensis* (Fairmaire) and *G. pictus* (Gebien), both identified as introductions from South America. The related *Poecilocrypticus formicophilus* Gebien, also native to southern South America (Steiner 1982), and *G. pictus* are not yet known from Virginia and northward. All four species occur on open sandy soil habitats in the southeastern United States, and *G. platensis* has spread to California and some Antillean islands. A key to these species can be found in the treatment on South Carolina darkling beetles (Ciegler in press). A fifth crypticine species, the Asian *Ellipsodes scriptus* (Lewis), was reported from Maryland (Kaszab 1975) as "eingeschleppt" (adventive or introduced) but no additional specimens have been found and it is presumably not established in North America.

Mapping the occurrences of these beetles in the Chesapeake Bay region is of interest because both *Gondwanocrypticus* species reach their current northern range limits there; the non-native *G. platensis* is a recent arrival and now more commonly collected than its indigenous congener. *Gondwanocrypticus obsoletus* was separated and identified in part because specimens in older (pre-1920s) collections were all one species; the earliest United States specimen records of the other species, long confused with *G. obsoletus*, did not show up until 1929 (Mobile, Alabama and southern Mississippi), indicating that this

second species, later identified as *G. platensis*, was introduced. Examination and comparisons with identified specimens from South America led to the identification of *G. platensis* (and *G. pictus*, which is not yet as widespread in the United States and was collected first in 1954 in Alabama). Both introduced species are found in association with imported fire ants (Hymenoptera: Formicidae), often collected under leaf litter around ant nests, and it is also interesting to note that the first detection of *G. platensis* closely followed that of the Black Imported Fire Ant (*Solenopsis richteri* Forel) at the same locality (Taber 2000), where both beetles and ants could have arrived in the same or similar dumps of soil ballast shipped from South America.

The two *Gondwanocrypticus* species that occur in the Chesapeake Bay region are black in color and about the same size, 3.9-4.6 mm long (0.15-0.18 in) (Figures 1-2). Separating the two is best done with examination of the basal antennal segments. In *G. obsoletus*, the antennomeres are reddish basally, gradually darkening to apex, with antennomeres 2 and 3 of similar color, form and size; in *G. platensis*, antennomeres 1 and 2 are pale reddish and the 3rd and others dark brown, and antennomere 2 is much shorter and paler compared to 3, which is two times as long as 2 and darkly pigmented in contrast. The dorsal luster or sheen is somewhat different between the species, with *G. obsoletus* uniformly dull, somewhat polished; *G. platensis* has the pronotum noticeably more shining than the relatively dull elytra. Profiles of the male genitalia in dorsal view are useful also, with the apical piece two times longer than wide, more than one fourth the length of the tegmen in *G. obsoletus*, versus a narrower apical piece, more than two times longer than wide, and less than one fourth the length of the tegmen in *G. platensis*. Images of *Gondwanocrypticus* posted on BugGuide (2014) all appear to be of *G. platensis*, but most are identified as *G. obsoletus*. The image of *G. obsoletus* figured by Dunford et al. (2005) is correctly identified and the antennal features are clear. Likewise, the image of a live *G. platensis* (Evans 2014) shows the antennal characters and dorsal luster for the correct species.

METHODS

Specimens are deposited in the United States National Museum of Natural History, Smithsonian Institution, Washington, DC, unless noted otherwise. Specimens in the Virginia Museum of Natural History, Martinsville, Virginia, are listed as "VMNH". Specimen label data below are quoted verbatim, with commas inserted for clarity; breaks between labels are separated by a forward slash. Inferred data and additional characters added in abbreviations are given in brackets. Most of the specimen records were collected by the authors, with names spelled out on labels, but abbreviated here as "WS" and "JS." The numbers of specimens bearing the same data follow in parentheses.

Figures 1 (left) and 2 (right), *Gondwanocrypticus obsoletus* (Say) and *G. platensis* (Fairmaire), respectively (Coleoptera: Tenebrionidae: Crypticini). Dorsal views of beetle, left antenna, and tegmen.

RESULTS

Gondwanocrypticus obsoletus (Say)

Delaware Record

Sussex County: "Del. [Sussex County] A* Rehoboth, 317, G. H. Dieke / VII, 3, 1944, beach washup / G. H. Dieke Colln. 1965" (1).

Maryland Record

Worcester County: "MARYLAND: Worcester Co., West Ocean City, at Sinepuxent Bay, 38°19'N, 75°06'W, 29 July 1991 / WS & JS collectors" (3).

Virginia Records

Accomack County: "VIRGINIA: Accomack Co., Chincoteague, 6-7 May 1989, WS & S. M. Fondreist" (12); same data except "12-14 May 1990 / WS, M. J. Molineaux, S. M. Fondreist et al. collectors" (2); same data except "37°56'35"N, 75°21'55"W, 5 November 2000, coll. WS & JS / Under leaf litter and matted grass on sandy soil, open turf behind salt marsh" (4); same data except "37°54'40"N, 75°23'55"W, 10 November 2006" (1); same data except "37°57'17"N, 75°20'37"W, 14 January 2001 / Under matted leaf litter & grass debris on sandy soil, open bank near forest and marsh / WS, JS, D. E. Beck collectors" (4); same data except "37°56'0"N, 75°22'12"W, 28 September 2013 / Under leaf litter on sandy soil, roadside; coll. WS, JS et al." (1); same data except "NE area along Deep Hole Road, 37°56'20"N, 75°20'52"W, 28 September 2013 / Under leaf litter on sandy soil, roadside; coll. WS, JS et al." (2) "VIRGINIA: Accomack Co., Chincoteague Wildlife Refuge, near Ed. Ctr., 37°54'32"N, 75°21'23"W, 9 November 2006 / WS & JS collectors" (5); "VIRGINIA: Accomack Co., Greenbackville, 25 October 1987, WS & J. M. Hill" (16); "VIRGINIA: Accomack Co., Wachapreague (Parramore I.), 8 June 1982, WS" (1).

Hampton: "Va. [with Casey dot code: "Fort Monroe,"] [Hampton City Co.] / Casey bequest 1925" (2); "Ft. Monroe [Hampton City Co.] Va. / Coll. Hubbard & Schwarz" (1).

Newport News: "Newport [City of Newport News] 4/4/[190]9 / Va. / H. W. Wenzel Collection" (2, in Ohio State University Collection, Columbus).

Northampton County: "VIRGINIA: Northampton Co., Cape Charles, 15 October 1984, WS & J. M. Hill" (4); "Cobbs Isd. [Northampton Co.] 20.8 Va / Coll. Hubbard & Schwarz" (1); "VIRGINIA: Northampton Co., Hog Is., W. side, 12-13 October 1988, J. M. Hill" (15); "VIRGINIA: Northampton Co., Kiptopeke, 2-5 October 1987 / WS, JS, J. M. Hill, J. J. Marshall collectors" (12); same data except "23 October 1987 / WS & J. Hill" (4); "VIRGINIA: Northampton Co., 3 km SE Townsend, 13 October 1984, WS & J. M. Hill" (13); same data except "14 October 1984" (6); same data except "4 October 1987 / WS, JS, J. M. Hill, J. J. Marshall collectors" (3).

Virginia Beach: "VIRGINIA: City of V[irgini]a. Beach, First Landing State Park, beach campground, 36°55.4'N, 76°2.8'W, 16 June 2007 / Under live oak leaf litter on sand, edge of gap in maritime forest / WS, JS, A. V. Evans et al. collectors" (2); "VIRGINIA: [City of Virginia Beach], Princess Anne Co., Virginia Beach, 1 May 1982, WS" (2); same data except "2 May 1982" (2).

(county unspecified):"Va. [state label only] / Henry Ulke Beetle Coll. CMNH acc. No. 1645" (1, in Carnegie Museum of Natural History, Pittsburgh).

Gondwanocrypticus platensis (Fairmaire)

Delaware Record

Sussex County: "USA: DELAWARE, Sussex County, Rehoboth Beach, 12 November 2006 / WS & JS collectors / With ants under matted thatch, open turf area" (3, each point-mounted with ant on same pin; ants identified as *Prenolepis imparis* [Say]).

Maryland Records

Anne Arundel County: "MARYLAND: A[nne]. Ar[un]d[e]l. Co., 10 km NE Annapolis, Sandy Point, 39°01'02"N, 76°24'13"W, 3 October 2012, Coll. WS" (3); same data except "East Beach, 39°0'50"N, 76°23'44"W, 12 December 2012, Coll. WS" (1); same data except "S. Beach, 39°0'31"N, 76°24'10"W" (1); same data except "16 October 2013 / Under leaf litter among grass crowns, upper edge of sand beach; coll. WS" (4); same data except "19 October 2013 / coll. WS & JS" (2); same data except "1 January 2014" (14).

Calvert County: "MARYLAND, Calvert Co., Scientists Cliffs, 38°31'N, 76°31'W, 22 August 1999, under driftwood and debris on sand beach / WS & JS et al. collectors" (7, associated with series of ants, *Pheidole* Westwood sp.); same data except "24 August 2002" (4), "Sept. 2003" (2), and "12 July 2009" (1); same data except "11 August 2002 / Under driftwood and debris on upper dry edge of sand beach; coll. WS & JS" (1); same data except "38°30'29"N, 76°30'27"W, 4 August 2013 / Under leaf litter among grass crowns, sand flats behind beach; colls. WS, JS, B. S. & S. E. Dixon" (1); "MARYLAND: Calvert County, Scientists Cliffs; Parkers Creek beach area, 38°32'13"N, 76°31'05"W, A[merican]. C[hestnut]. L[and]. T[rust].; 28 August 2007 / Under leaf litter among *Cakile* [Mill. (Brassicaceae)]and *Ammophila* [Host (Poaceae)] on upper dry zone of sand beach; colls. J. Prena, WS, M. Gates, M. Buffington" (1); "MARYLAND, Calvert Co., Solomons, 38°19'43"N, 76°28'04"W, 11 May 2003 / WS & JS collectors" (4); Same data except "38°19'46"N, 76°28'07"W, 21 October 2011 / WS, JS, E. L. Nakash collectors" (3).

Charles County: "MARYLAND: Charles Co., Purse State Park, 4 km. SW Nanjemoy, 38°26'N, 77°15'W, 25 August 2002 / Under leaf litter and wood debris on beach; Colls. WS, JS, W. M. Johnson, R. Dabill" (3); same data except "38°25'47"N, 77°15'24"W, 2 February 2014 / Found dead under leaf litter on sand at upper edge of beach; colls. WS, JS, E. L. Nakash" (1).

Dorchester County: "MARYLAND: Dorchester Co., Cambridge, beach at Choptank River, 38°34'21"N, 76°03'54"W, 26 December 2013 / On loose sandy soil under leaf litter among grass crowns; Colls. K. Kanda & WS" (2); "MARYLAND: Dorchester Co., 7 km SSE Church Creek, 38°27'N, 76°08'W, 24 July 1999, WS et al. / Under matted grass thatch on sandy roadside turf, dry bank above marsh" (4); same data except "7 km SE Church Creek, 38°26'32"N,76°06'40"W, 30 March 2013 / Colls. WS, N. E. Blanton et al." (2); "MARYLAND: Dchstr. Co., Hooper Island, Richland Point, 38°15'N, 76°11'W, 20 February 2000, collectors WS & JS" (6).

Prince George's County: "MARYLAND: Pr[ince]. Georges]. Co., Cheverly, 38°56'N, 76°55'W, 12 August 2005, coll. WS & JS / At black light in tree canopy, mixed broken forest and residential area" (1); same data except "11 August 2009" (1) and "4 July 2012" (1).

Queen Anne's County: "MARYLAND: Q[uee]n. Anne's Co., Matapeake Beach, 4 km SW Stevensville, 38°57'25"N, 76°21'16"W, 21 October 2013 / Under leaf litter among grass crowns, upper edge of sand beach; coll. WS" (4); "MARYLAND: Queen Anne's Co., Pier One Marina near Stevensville, small beach, 38°58'54"N, 76°20'04"W, 20 January 2010, coll. WS / Under leaf litter and drift wood debris among grass crowns, sand bank above beach" (1); "MARYLAND: Queen Anne's Co., 10 km SSW Stevensville, Queen Anne Marina at Prices Creek inlet, 38°53'54.6"N, 76°21'55.7"W, 21 December 2013 / Under leaf litter at turf edge, upper edge of sand beach; colls. WS & JS" (4).

St. Mary's County: "MARYLAND: St. Marys Co., Piney Point, 38°08'N, 76°32'W, 12 October 1994, WS colr." (2); "MARYLAND: St. Marys County, Point Lookout, 38°03'N, 76°19'W, 19 July 1992 / WS & JS collectors" (1, specimen found dead); same data except "1 January 1993" (8); same data except "27 February 1994" (7, specimens found dead); same data except "12 October 1994, WS colr." (8, associated with series of 3 ant species, *Lasius neoniger* Emery, *Tetramorium* Mayr sp., *Pheidole* sp.); same data except "9 October 1995 / WS & JS collectors" (7); "MARYLAND: St. Marys Co.; St. George I. (NW end), 38°08'N, 76°30'W, 27 February 1994 / WS & JS collectors" (4, specimens found dead); same data except "12 October 1994, WS colr." (1).

Somerset County: "MARYLAND: Somerset County, Crisfield, 37°59'N, 75°51'W, 11 April 1993 / WS & JS collectors" (1); "MARYLAND: Somerset Co., Smith Island, Tylerton, 37°58'N, 76°02'W, 4 July 2006 / coll. WS, JS et al." (1).

Talbot County: "MARYLAND: Talbot Co., McDaniel, Wades Point, 38°49'40"N, 76°17'45"W, 29 September 2008, WS et al." (18, associated with series of 2 ant species, *Lasius interjectus* Mayr, *Tetramorium* sp.); same data except "2 October 2011" (2), "4 October 2011" (2), "30 September 2012" (6), and "4 October 2013" (5); "MARYLAND: Talbot Co., 7 km S Trappe at Choptank River, 38°35'N, 76°02'W, 7 November 2009 / Under leaf litter beneath *Baccharis halimifolia* [L. (Asteraceae)] on sand, upper beach; coll. WS" (1); Same data except "38°35'16"N, 76°02'34"W, 1 November 2010 / Under matted dead grass and leaf litter, sandy soil bank tidal river; Coll. WS" (5); same data except "38°35'14.5"N, 76°02'33"W, 26 December 2013 / Under matted dead grass and leaf litter, sandy soil bank tidal river; Colls. K. Kanda & WS" (5).

Worcester County: "MARYLAND: Worcester County, 9 km SE Berlin at Sinepuxent Bay, 38°15'N, 75°09'W, 30 July 2004, Coll. WS & JS" (1); "MARYLAND: Worc. Co., 4 km S Pocomoke City, 38°01'N, 75°32'W, 13 November 1994 / WS & JS collectors" (4); "MARYLAND: Worc. Co., 6 km S Pocomoke City, 38°0'14"N, 75°32'35"W, 29 September 2013 / Under leaf litter on sandy soil, sparse turf, roadside; WS & JS collectors" (1, associated with series of 2 ant species, *Prenolepis imparis* (Say),

Tetramorium sp.); "MARYLAND: Worc. Co., Isle of Wight; Poplar Point, 38°23'20"N, 75°06'30"W, 28 July 1999 / WS & JS collectors / Under matted grass thatch on sandy open turf, roadside corner near bay beach" (9); same data except "10 September 2000, Coll. WS / Under drift debris on small beach at salt marsh edge" (1); same data except "29 October 2000 / Under matted grass and leaf litter on sandy soil, edge of depression along trail near shore" (3); same data except "28 July 1999 / At black lights in sandy open areas and mixed forest & scrub" (2); "MARYLAND: Worcester County, North Ocean City, 38°23'34"N, 75°06'55"W, 27 July 1999 / WS, JS, M. J. & R. Molineaux collectors" (1); same data except "2 August 2002" (6); "MARYLAND: Worcester Co., Ocean City, inlet marina, 38°19'38"N, 75°05'24"W, 27 December 2009 / Under leaf litter and rosette plants on open sandy soil; Coll. WS & JS" (3); "MARYLAND: Worcester Co., Ocean City, inlet marina, 38°19'38"N, 75°05'24"W, 27 December 2009 / Under leaf litter and rosette plants on open sandy soil; Coll. WS & JS" (3); "MARYLAND: Worcester County, Public Landing, 38°08'N, 75°17'W, 13 August 1993 / WS & JS collectors" (2); "MARYLAND: Worc. Co., Shad Landing area 6 km SW Snow Hill, 38°08'N, 75°27'W, 14 August 1993 / WS & JS collectors" (1); "MARYLAND: Worc. Co., 10 km WNW Snow Hill, 38°11'N, 75°30'W, 27 July 1997, cols. WS & JS / At black light in mixed open forest, edge of dry open sandy area" (1).

Virginia Records

Accomack County: "VIRGINIA: Accomack Co., Chincoteague, 6-7 May 1989, WS & S. M. Fondreist" (12); same data except "37°55'58"N, 75°22'31"W, 14 January 2001 / WS, JS, D. E. Beck collectors" (3); same data except "3 November 2001" (3, associated with series of ants, *Tapinoma sessile* [Say]); same data except "37°56'35"N, 75°21'55"W, 8 November 2006 / WS & JS collectors" (4); same data except "10 November 2006" (1); same data except "37°56'02"N, 75°22'15"W, 4 September 2010 / WS, JS et al. collectors" (2); same data except "6 September 2010" (2), "7 September 2010" (1), "4 September 2011" (3), "5 September 2011" (3), "27 September 2013" (2); same data except "37°56'02"N, 75°22'20"W, 5 September 2010" (1); same data except "37°56'0"N, 75°22'12"W, 28 September 2013 / Under leaf litter on sandy soil, roadside; coll. WS, JS et al." (1); same data except "37°56'01"N, 75°22'28"W, 28 September 2013 / Found at night under leaf litter on sandy soil, roadside; WS, JS et al." (1); same data except "NE area along Deep Hole Road, 37°56'20"N, 75°20'52"W, 28 September 2013 / Under leaf litter on sandy soil, roadside; coll. WS, JS et al." (2); "VIRGINIA: Accomack Co., Wachapreague, 9 September 1985, WS" (13).

Greensville County: "VIRGINIA: Greensville Co., Skippers, 34°33'N, 79°15'W / 20 Sept. 1994, WS & JS collectors" (1); same data except "25 November 1997" (3).

Henry County: "USA: VA, Henry Co., Martinsville, 6 May [19]93, J. M. Anderson" (1, VMNH).

Isle of Wight County: "USA: VA, Isle of Wight Co., Antioch Pines N[atural]A[rea]P[reserve], unburned area, 10km S of Zuni, 30 April 2002, P. Koury, VDNH Survey" (1, VMNH).

James City County: "VIRGINIA: James City Co., Norge, 37°22'N, 76°46'W, 7 March 1992 / WS & JS collectors" (9); same data except "6 March 1993" (7), "4 March 1995, WS & JS" (30).

New Kent County: "VIRGINIA: New Kent Co., 5 km SW New Kent, 22 February 2007 / WS & JS collectors" (3).

Northampton County: "VIRGINIA: Northampton Co., Cape Charles, 5 October 1986 / WS, JS, J. M. Hill, J. J. Marshall collectors" (29); same data except "15 October 1984, WS & J. Hill" (2); "VIRGINIA: Northampton Co., Kiptopeke, 37°10'58"N, 75°58'08"W, 19 December 2006 / WS, W. N. Mathis, O. S. Flint collectors" (5); "USA: VA, Northampton Co., Kiptopeke State Park, 12 May 1996, R. S. Hogan" (2, VMNH); "VIRGINIA: Northampton Co., Oyster, 11 October 1976, WS" (1); "USA: VA, Northampton Co., Savage Neck Dunes N[atural]A[rea]P[reserve], 20 May-23 June 1999, A. C. Chazal, VDNH Survey" (2, VMNH); same data except "22 Apr 1999, S. M. Roble, VDNH Survey" (1, VMNH); same data except "24 June/28 July 1997, A. K. Foster, A. C. Chazal, pit fall array, interdunal pond" (1, VMNH).

Pittsylvania County: "USA: VA, Pittsylvania Co., Cascade Crk. at Va. Hwy. 700, 28 Aug 1989, R. L. Hoffman" (1, VMNH).

Surry County: "VIRGINIA: James River, Surry Co., Scotland, 25 April 1988, on beach, M. J. Molineaux" (2).

Virginia Beach: "USA: VA, Virginia Beach, City, Camp Pendleton Annex, dune pitfall array, N36.81376, W75.9672, 19 Mar-6 May 2008, A.V. Evans, maritime dune grassland" (2, VMNH); "USA: VA, Virginia Beach, City, Dam Neck Naval Surface Warfare Center, dune drift fence site, 25 June 1991, K. A. Buhlmann, pit fall array, interdunal swale / VDNH-Camp Pendleton Annex Project" (1, VMNH); "USA: VA, Virginia Beach, City, False Cape State Park, Barbour Hill, 17 Aug 1998, S. M. Roble, C. S. Hobson, A. C. Chazal, uv light trap, dunes / VDNH-Camp Pendleton Annex Project" (1, VMNH); same data except "beach campground, N36°55.4', W76°2.8' 15-17 June 2007, WS, JS, under litter on sandy soil / 2007 VA BEETLEBLITZ" (2, VMNH); same data except "Wash Woods E[nvironmental] E[ducation] C[enter], 17/18 August 1998, mercury vapor light, dunes" (1, VMNH); same data except "17 Aug 1998, S. M. Roble, C. S. Hobson, A. C. Chazal, uv light trap, dunes" (1, VMNH); "VIRGINIA: [City of Virginia Beach], Princess Anne Co., 15 km E. Norfolk at Lynnhaven Inlet, 6 August 1984, WS & D. Bogar" (1); "VIRGINIA: [City of Virginia Beach], Princess Anne Co., Sandbridge Beach, 5 August 1984, WS & D. Bogar" (1); "VIRGINIA: [City of Virginia Beach], Princess Anne Co., Virginia Beach, 2 May 1982, WS" (1).

York County: "VIRGINIA: York County, 12 km NNW Williamsburg, 37°21'N, 76°44'W, 5 March 1995, WS & JS" (2) "USA: VA, York Co., Yorktown Weapons Station, hardwood drift fence, 17 Aug 1990, K. A. Buhlmann, pit fall array, hardwoods, VDNH Survey" (1, VMNH).

West Virginia Record

Morgan County: "WV, Morgan Co., Sleepy Cr. Forest, 27 VII-[20]12, J. Glaser / at M[ercury] V[apor] light" (1).

DISCUSSION

Gondwanocrypticus obsoletus is flightless and restricted to coastal sandy areas. Only single collection sites in Delaware and Maryland are known. More common southward, it has been found at inland sandhill scrub habitats in addition to coastal dunes. It co-occurs with *G. platensis* but is usually found in less disturbed, natural areas with leaf litter on sand at edges of gaps in vegetation. The adventive *G. platensis* may be displacing *G. obsoletus*, but is most common in disturbed open soil areas such as roadside turf and lawns. It is winged and a successful disperser, as demonstrated by collections at lights, including the tree canopy-level specimens taken at Cheverly, Maryland. It is not restricted to coastal sands, but is most common along Chesapeake Bay beach strands, in habitats as described on many specimen labels.

The earliest known Virginia specimen of *G. platensis* was taken in 1976 (Oyster, Northampton County); in Maryland, 1992 (Point Lookout, St. Mary's County); Delaware, 2006 (Rehoboth Beach, Sussex County); and West Virginia, 2012 (Morgan County). Along Chesapeake Bay shores north to Anne Arundel and Queen Anne's Counties, arrival of the beetle was detected later, 1999 to present. At one locality monitored annually for several decades for other tenebrionids in the same habitats (Sandy Point, Anne Arundel County), *G. platensis* did not appear until 2012.

There is some evidence of winter mortality in *G. platensis* at a number of sites. Specimens have been found dead following hard freeze events. Milder winters may allow beetles to expand their range northward, but then get pushed south again by severe frost. After two severe hard freezing events, the polar vortex of 6-8 January 2014 and another hard freeze of 22-24 January 2014 (lows -12 to -15°C [10 to 5°F]), the population of *G. platensis* at the Sandy Point sites has apparently been impacted; rather abundant and easily detected on 1 January 2014, no beetles could be found on 16 July 2014.

Many specimen records from localities south of Virginia are associated with fire ants, mostly the Red Imported Fire Ant (*Solenopsis invicta* Buren), being commonly found under litter around the ant mounds, apparently as scavengers of ant debris. The beetle is evidently not dependent on this species as it has spread and is colonized beyond the ant's current distribution limits (Taber 2000). It is unclear how dependent or myrmecophilous the beetles may be. As listed in the specimen data, several genera and species of ants, both native and exotic, have been associated with *G. platensis* but the possible relationships need more study. Larvae have been reared from adult *G. platensis* in captivity, in loose sandy soil from the collection site, and fed on oatmeal; development was completed without the presence of ants.

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First Western Hemisphere Record for *Plesiophthalmus spectabilis* Harold (Coleoptera: Tenebrionidae: Amarygmini), an Asian Darkling Beetle Newly Found in Maryland

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A single live specimen of this rather large (17 mm [0.67 in]), shining, black, darkling beetle (Coleoptera: Tenebrionidae) (Figures 1, 2) with long appendages was collected in August 2013 by FP on the campus of Baltimore City Community College (BCCC), and kept for identification. Based on comparison of material in the United States National Museum of Natural History (USNM), Smithsonian Institution, Washington, DC, and descriptions in literature, the specimen was determined by WS as *Plesiophthalmus spectabilis* Harold, an Oriental member of the tribe Amarygmini. The genus is strictly Oriental (Masumoto 1989a) and this species is known to be widespread in Japan, Korea, China, and Taiwan (Masumoto 1989b). No previous collection records are known for this species in the Western Hemisphere.

The dry, pinned beetle is labeled as follows:

> "MARYLAND: Baltimore City Community College; found on clothing in building, 16 August 2013; possibly from Carroll Co., MD; Coll. F. Paraskevoudakis".

The specimen is deposited in the collection of the USNM. As the label indicates, the source of the beetle is uncertain and it may have come from localities in the Patapsco area of Finksburg (Carroll County), Maryland. These localities possibly are homes at 3200 Patapsco Road or at an outdoor site on nearby 939 Wesley Road visited by FP that morning before going to BCCC. Whether it represents an established population or merely a single imported occurrence is uncertain, but we report and illustrate it here so that, if established in North America, it can be recognized and monitored. Collectors should be aware that this Asian species could be naturalized and spreading.

Amarygmini can be recognized by the large eyes which embrace the antennal insertions. In the key to North American tenebrionid genera (Aalbu et al. 2002), *Plesiophthalmus* Motschoulsky species would key to *Meracantha* Kirby. It should be noted that *Meracantha contracta* (Beauvois), the only member of the genus, is flightless (Steiner 1999) and that members of the other North American genus of the tribe Amarygmini, *Cymatothes* Dejean, are fully winged; this condition is erroneously reversed in the key. The online key by Dunford et al. (2005) correctly uses characters related to wing condition (prominence of elytral humeri) and it illustrates the *Meracantha* and *Cymatothes* species. *Plesiophthalmus spectabilis* is also fully winged, with rather

prominent elytral humeri, but is more similar to *M. contracta* in its shining luster and in having a distinct tooth on the front of the femur at about the apical one-third. Larvae of this and related species live in rotting wood (Hyashi 1966, 1968) and have distinctive concave abdominal apices. *Meracantha contracta* is the only other member of Amarygmini known from Maryland (Steiner 2008) and it is common in mature forest habitats.

Figure 1. *Plesiophthalmus spectabilis* Harold (Coleoptera: Tenebrionidae: Amarygmini). Female, dorsal view. Length of beetle 17 mm (0.7 in).

Figure 2. *Plesiophthalmus spectabilis*. Female, frontal view. Greatest width of head at eyes 3 mm (0.1 in).

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Identifying the Nuisance Black Flies (Diptera: Simuliidae) of Washington County, Maryland

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ABSTRACT: Residents of southern Washington County, Maryland, report black fly (Diptera: Simuliidae) swarms as a recurring summer nuisance. To determine the source of the flies, we collected and identified specimens of larvae and adults throughout the area of complaint during the spring and summer of 2013. A survey was provided to residents to gauge the extent of the problem. All of the collected adult flies were identified as *Simulium jenningsi* Malloch, a known pest in the Mid-Atlantic states associated primarily with large rivers. *Simulium jenningsi* larvae were found only in Antietam Creek and in the Potomac River, the largest bodies of water sampled during this study. The survey responses coincided with those of the sampling of Simuliidae, an indication that the flies negatively affected human outdoor activities during the summer months.

INTRODUCTION

Black flies (Diptera: Simuliidae) are a worldwide pest, with adult females forming large, biting swarms that can harm both humans and livestock. Black flies in North America do not transmit human diseases, but they do serve as vectors for bovine onchocerciasis in horses and cattle and for leucocytozoonosis in fowl such as domestic turkeys (Adler and McCreadie 2002). Swarms of some North American species of black flies can grow large enough to cause extreme blood loss in humans and animals (Adler et al. 2004). However, a more common complication from black fly swarms in the Mid-Atlantic region is disruption of human outdoor activities. Reports of disruptive black fly swarms occurring annually during the summer months in southern Washington County, Maryland, reached our laboratory in the spring of 2013. We agreed to help the residents that summer by gathering baseline data about the identity and possible breeding locations of the nuisance flies.

Although black flies are terrestrial as adults, their larvae and pupae are found in fast-flowing fresh water. After emergence, females mate and begin searching for a mammal or bird from which to obtain a blood meal, the protein from which is required for egg production. Black flies in the Mid-Atlantic region can travel long distances to find blood, as demonstrated by Amrine (1982), who found adult flies 56 km (34.9 mi) from their larval source in West Virginia. Partly because of these dispersal capabilities, suppression of black fly populations is conducted primarily by targeting larval habitats. For example, Pennsylvania has successfully reduced their black fly populations through release of the bacterial strain *Bacillus thuringiensis israelensis* (Bti) into streams supporting large populations of pest larvae (PDEP 2014).

Before a similar management plan for black flies in Washington County could be created, knowledge was needed regarding the species involved and the source of the larvae. Our goal was to collect baseline information concerning the adult flies and the source of the larvae. Our three research objectives were 1) to determine the species of black fly causing the problem, 2) to locate the source of the larvae, and 3) to determine the extent of the black fly nuisance by surveying Washington County residents and analyzing the results of the survey. In addition, we established a website (http://mdblackfly.com) to keep residents informed of our progress throughout the sampling and identification process and to enlist volunteers to help with our efforts.

METHODS

Sampling of Adult Flies

Sampling kits containing six 60-ml (2-oz) vials containing 80% ethanol were distributed to Washington County resident volunteers in early spring of 2013. Residents were instructed to collect nuisance flies throughout the summer and to use one vial per collecting date and location. The use of volunteer-collected adult flies ensured that only those causing a nuisance to residents were identified. All samples were retrieved in October 2013 and identified to species by use of keys (Adler et al. 2004).

Sampling of Larvae

Road-accessible streams were sampled for black fly larvae from May through August 2013 in southern Washington County. Rocks, woody debris, leaf packs, and vegetation were checked for adhering larvae, which were removed by use of forceps and preserved in either Carnoy's fixative or 80-100% ethanol. Sampling was conducted only when water levels were low enough to allow safe access by technicians. This resulted in limited sampling in the Potomac River, which experienced high water levels during much of the survey period. Late-instar larvae were identified to species or species complex by use of keys (Adler et al. 2004). Only a small portion of larvae from each site could be identified beyond genus because of the necessity of development of gill filaments for further taxonomic resolution; thus our results refer exclusively to mature larvae.

Online Survey

A survey was designed by use of Google Forms to gauge both the perceived intensity and geographic spread of black fly nuisance across Washington County. The online survey was accessible via a URL posted to our website (http://mdblackfly.com), and also was available in paper format to anyone who participated in collection of adult flies. The 14 survey questions addressed three major categories: geographic range, time of activity, and level of irritation. Washington County residents were asked to 1) provide locations where they had encountered black flies, 2) estimate peak periods of seasonal and daily activity, and 3) describe the extent to which black flies were a nuisance. Surveys were distributed in spring 2013, and the responses were collected and compiled for analysis during September 2013.

RESULTS

Sampling of Adult Flies

From the 44 vials containing adult flies collected by resident volunteers, 423 adult female black flies were determined to be in identifiable condition. Specimens were sent to us from residents in and around the towns of Boonsboro, Brownsville, Keedysville, Knoxville, Rohrersville, and Sharpsburg, all located within Washington County (Figure 1). Sampling dates ranged from 25 April to 2 October 2013, with more than half of the flies having been collected during July and August. All specimens were identified as belonging to the *Simulium jenningsi* Malloch species complex. A subset of 20 specimens was confirmed as *S. jenningsi* sensu stricto (Figure 2) by Peter H. Adler (Professor, Department of Entomology, Soils, and Plant Sciences, Clemson University, Clemson, South Carolina), a black fly expert. Because of the uniformity of key identifying features among our specimens, all of the remaining flies conformed to *S. jenningsi* sensu stricto.

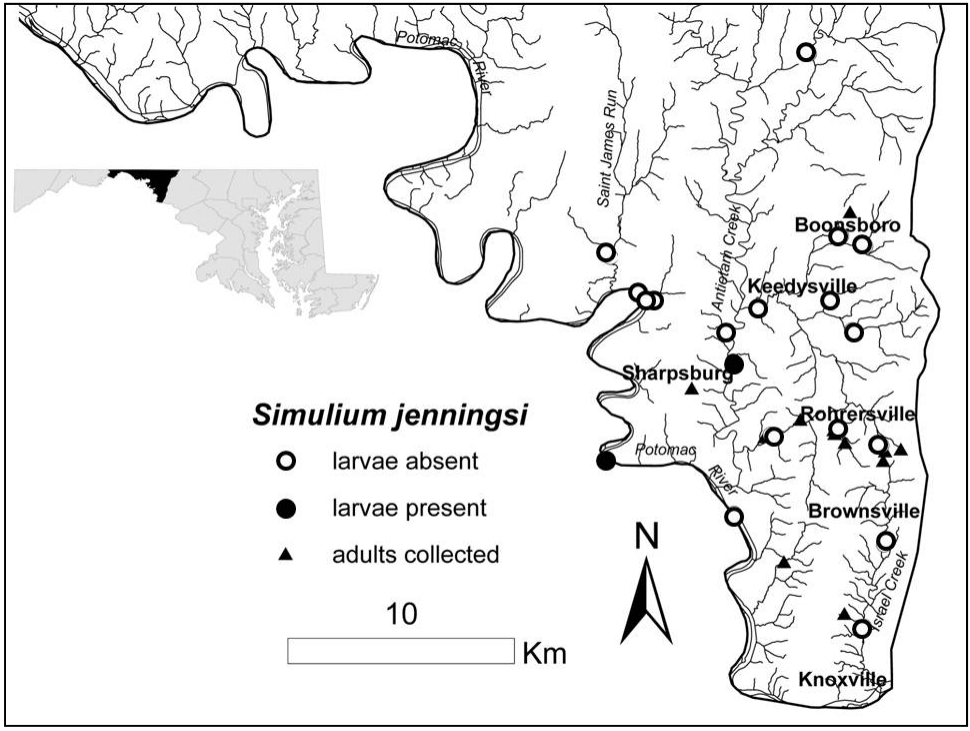

Figure 1. Map of collection sites of adult and larval black flies in Washington County, Maryland. Larval sites are differentiated by presence or absence of *Simulium jenningsi*. All adult flies collected at each site were *S. jenningsi*.

Figure 2. *Simulium jenningsi* Malloch sensu stricto (Diptera: Simuliidae). Adult. (Photographed by Jake Bohart.)

Sampling of Larvae

Of the 19 different stream reaches sampled (Figure1), larvae of nine species or species complexes were found: *Prosimulium mixtum* Syme and Davies, *Simulium jenningsi*, *S. luggeri* Nicholson and Mickel, *S. parnassum* Malloch, *S. tuberosum* (Lundstrom) species complex, *S. vandalicum* Dyar and Shannon, *S. venustum* Say species complex, *S. verecundum* Stone and Jamnback, and *S. vittatum* (Zetterstedt) species complex. The species distribution by sampling site and month is shown in Table 1. Representative specimens of each of these species or species complexes were confirmed by Dr. Adler. Voucher specimens were maintained in the Lamp Laboratory, Department of Entomology, University of Maryland. Larvae of *S. jenningsi* were found only in the Potomac River and Antietam Creek. In samples from the Potomac River, *S. jenningsi* and *S. luggeri* (*S. jenningsi* species group) were the only species found. In contrast, Antietam Creek also contained larvae of the *S. tuberosum* and *S. vittatum* species complexes. In the Potomac River, submerged vegetation was a common substrate that hosted large numbers of larvae.

Online Survey

We collected 22 responses to the online survey, the location of the submitters coincided geographically with the sampling areas for larvae and adult flies. Survey results reported a high level of annoyance at all sites reported, with 95% of respondents indicating that they had encountered black flies at their place of residence and 100% indicating that they had encountered black flies at one or more additional locations. Peak black fly abundance was perceived during July, with flies persisting throughout all warm months between spring and fall. Survey results indicated that black flies were active on warm

days (21-32° C [70-90° F]) with little to no breeze and varying levels of cloud cover. When asked to rate level of irritation using a Likert scale with 1 being "not irritating" and 5 being "very irritating," 86% of survey takers rated black flies as "very irritating." Irritating behaviors included swarming around the face and body and biting (Table 2). Respondents also indicated that their outdoor activities often were disrupted or prevented by swarming flies.

Table 1. Location and stream order of sampling sites of larvae and associated species of larvae by sampling date. Stream sampling was conducted once per month from May through August 2013. Species identified from each site are listed. Strahler stream order refers to the relative size of the river or stream, with a classification of "1" representing headwater streams and higher numbers representing exponentially larger streams.

Sampling Location	GPS Coordinates	Stream Order	May	June	July	August
Antietam Creek at MD 34	39.465 -77.725	5	*S. tuberosum SC* *S. vittatum SC*	*S. jenningsi* *S. tuberosum SC*	*S. jenningsi*	
Israel Creek at Garretts Mill Rd.	39.353 -77.685	3	*S. tuberosum SC*			
Little Antietam Creek headwaters at Trego Rd.	39.431 -77.678	2	*P. mixtum* *S. tuberosum SC* *S. vandalicum* *S. venustum SC*			
Little Antietam Creek at Dogstreet Rd.	39.477 -77.725	3	*S. tuberosum SC*			
Potomac River below confluence with Antietam Creek	39.406 -77.740	6	*S. luggeri*			
Sharman Branch at Burnside Bridge Rd.	39.434 -77.713	2	*S. parnassum* *S. tuberosum SC* *S. vandalium*			
Beaver Creek at US 40	39.578 -77.656	3		*S. vittatum SC*		
Dog Creek at Mt. Carmel Church Rd.	39.468 -77.662	2		*S. tuberosum SC*		
Israel Creek at Brownsville Rd.	39.383 -77.667	3		*S. tuberosum SC*		
Little Antietam headwaters at Nicodemus Mill Rd.	39.481 -77.670	1		*S. venustum SC* *S. vittatum SC*		
Little Antietam Creek at Keedysville Rd.	39.482 -77.707	4		*S. tuberosum SC* *S. vittatum SC*		
Eastern Branch of Little Antietam Creek at MD 34	39.505 -77.658	4			*S. tuberosum SC* *S. vittatum SC*	
St. James Run at Sprecher Rd.	39.514 -77.777	3			*S. tuberosum SC*	
Unnamed stream at Bowie Rd. near C&O Canal	39.494 -77.763	1			*S. tuberosum SC*	
Unnamed stream at US 40 in Boonsboro	39.499 -77.647	2			*S. tuberosum SC* *S. vittatum SC*	
Potomac River at Shepherdstown	39.437 -77.800	6				*S. luggeri* *S. jenningsi*
Potomac River at Taylors Landing	39.499 -77.767	6				*S. luggeri*
Unnamed stream at Bent Willow Rd.	39.421 -77.658	1				*S. verecundum*
Unnamed stream at Remsburg Rd. near C&O Canal	39.495 -77.761	1				*S. tuberosum SC*

Table 2. Annoying behavior of black flies. A total of 22 respondents completed our survey. When asked to describe annoying behaviors of black flies, all respondents described black flies swarming around the face and body. In addition, many indicated that they had been bitten by black flies, some experiencing a strong reaction. When asked to rate their level of irritation at black flies, all respondents rated black flies as either 4 (irritating) or 5 (very irritating).

In what ways is the presence of black flies irritating?	Responses	Percentage
Biting	17	77%
Swarming around face/body	22	100%
Other (flying into eyes/ears, severe reaction to bites)	5	23%

On a scale of 1 to 5, how irritating is the presence of black flies to you?	Responses	Percentage
1 (not irritating)	0	0%
2 (occasionally irritating)	0	0%
3 (somewhat irritating)	0	0%
4 (irritating)	3	14%
5 (very irritating)	19	86%

DISCUSSION

There are 61 species of black flies in the northeastern United States (Cupp and Gordon 1983). Washington County has more than 1000 km (621 mi) of total stream length, along which larvae of nine species of black flies were found at 19 sampled sites. When the very high potential for black fly nuisance in Washington County is considered, it is fortunate that only one species, *S. jenningsi*¸ is a nuisance black fly in this area. *Simulium jenningsi* is a well-known pest species with larvae requiring specific habitats. Washington County residents have expressed a strong desire to resolve this pest problem, and their continued involvement in our study, in conjunction with our baseline results, will help ensure the success of future research or management plans.

Simulium jenningsi is a species with historical precedence as a pest in Maryland and its neighboring states. A study conducted in response to similar nuisance reports from Prince George's County during the 1950s identified *S. jenningsi* as the species of interest (McComb and Bickley 1959). *Simulium jenningsi* also has been a species of major concern in Pennsylvania (PDEP 2014) and West Virginia (Amrine 1982). While *S. jenningsi* occasionally bites humans, its primary method of annoyance is through dense swarming around the face and ears (McComb and Bickley 1959). Our stream survey found larvae of *P. mixtum*, *S. luggeri*, *S. parnassum*, and the *S. venustum* species complex, which are pests of humans in other areas of North America, but we found no adult flies in our sampling. It is unknown why species cause nuisance problems in certain areas but not others (Adler et al. 2004).

Although, *S. jenningsi* larvae were found in both Antietam Creek and the Potomac River, we think that the Potomac is the more likely source of large numbers of *S. jenningsi* adults. *Simulium jenningsi* is predominantly a large-river species. McComb and Bickley (1959) attributed the large numbers of *S. jenningsi* adults that they found to the Potomac

River, and while Amrine (1982) found *S. jenningsi* larvae in some smaller rivers in West Virginia and nearby Virginia, the majority of the flies emerged from the New River, the largest river in that region. Because early-instar larvae were not identified in our study, our results likely underestimate the presence of *S. jenningsi* at the Potomac River sites, where we observed extremely large numbers of larvae attached to submerged vegetation. *Simulium luggeri*, a member of the *S. jenningsi* species group, was found at every site we sampled in the Potomac River; it is known to cohabit with *S. jenningsi* larvae (McComb and Bickley 1959).

Successful research and management of black flies in Washington County will require the involvement of Washington County residents. Our survey results provide insight into the perspectives of the local community, whose members largely regard black flies as a substantial annoyance. Survey respondents made it clear that their quality of life and perceived property values were greatly reduced by the presence of black flies. Many participants indicated that they could not enjoy any outdoor activity, including gardening, hiking, and sporting events, because of the presence of black flies. Our survey respondents perceived an immediate need for a treatment plan to control black flies to make their yards, neighborhoods, and parks livable. Because of the level of irritation experienced from swarms of black flies, many participants had a vested interest in the outcome of this issue, making our identification of the source and species of nuisance black flies timely.

To facilitate efficient management strategies, further research is needed to determine which areas of the Potomac River are the most productive sites of *S. jenningsi*. This species often occurs in large numbers below dams and confluences of large rivers (McComb and Bickley 1959, Amrine 1982). We think that the confluence of the Shenandoah and Potomac Rivers may provide a nutrient-rich habitat for *S. jenningsi* larvae. Many adult black flies were collected in, and many survey replies originated from Pleasant Valley, between Elk Ridge and South Mountain, which is directly downstream of the confluence of these two major rivers. We intend to focus on this region of the Potomac River in future projects.

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CONTENTS

COVER PHOTOGRAPH

Adult Kudzu Bug, *Megacopta cribraria* (Fabricius) (Hemiptera: Plataspidae) on kudzu, *Pueraria montana* (Lour.) Merr. (Fabaceae). 25 July 2013, southern Anne Arundel County, Maryland.

Photographed by Michael J. Raupp
Department of Entomology, University of Maryland College Park