

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 McCreddie 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, Rohrsersville, 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.

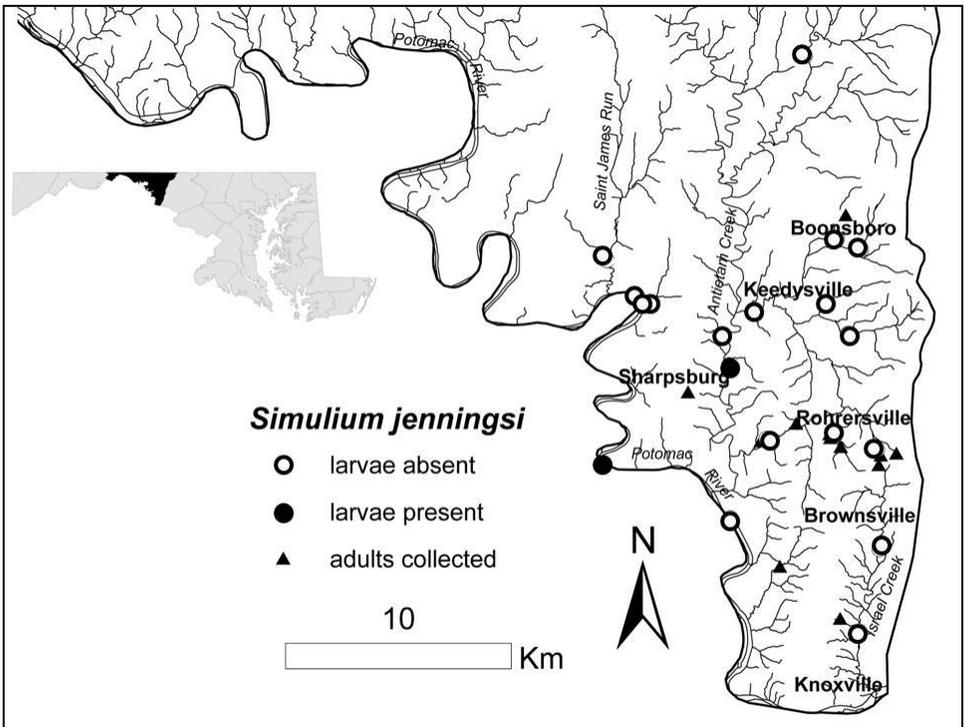


Figure 1. Map of collection sites of adult and larval black flies in Washington County, Maryland. Larval sites are differentiated by presence or absence of *Simulium jenningsi*. All adult flies collected at each site were *S. jenningsi*.



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

Sampling of Larvae

Of the 19 different stream reaches sampled (Figure 1), 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	<i>S. tuberosum</i> SC <i>S. vittatum</i> SC	<i>S. jenningsi</i> <i>S. tuberosum</i> SC	<i>S. jenningsi</i>	
Israel Creek at Garretts Mill Rd.	39.353 -77.685	3	<i>S. tuberosum</i> SC			
Little Antietam Creek headwaters at Trego Rd.	39.431 -77.678	2	<i>P. mixtum</i> <i>S. tuberosum</i> SC <i>S. vandalicum</i> <i>S. venustum</i> SC			
Little Antietam Creek at Dogstreet Rd.	39.477 -77.725	3	<i>S. tuberosum</i> SC			
Potomac River below confluence with Antietam Creek	39.406 -77.740	6	<i>S. luggeri</i>			
Sharman Branch at Burnside Bridge Rd.	39.434 -77.713	2	<i>S. parnassum</i> <i>S. tuberosum</i> SC <i>S. vandaliium</i>			
Beaver Creek at US 40	39.578 -77.656	3		<i>S. vittatum</i> SC		
Dog Creek at Mt. Carmel Church Rd.	39.468 -77.662	2		<i>S. tuberosum</i> SC		
Israel Creek at Brownsville Rd.	39.383 -77.667	3		<i>S. tuberosum</i> SC		
Little Antietam headwaters at Nicodemus Mill Rd.	39.481 -77.670	1		<i>S. venustum</i> SC <i>S. vittatum</i> SC		
Little Antietam Creek at Keedysville Rd.	39.482 -77.707	4		<i>S. tuberosum</i> SC <i>S. vittatum</i> SC		
Eastern Branch of Little Antietam Creek at MD 34	39.505 -77.658	4			<i>S. tuberosum</i> SC <i>S. vittatum</i> SC	
St. James Run at Sprecher Rd.	39.514 -77.777	3			<i>S. tuberosum</i> SC	
Unnamed stream at Bowie Rd. near C&O Canal	39.494 -77.763	1			<i>S. tuberosum</i> SC	
Unnamed stream at US 40 in Boonsboro	39.499 -77.647	2			<i>S. tuberosum</i> SC <i>S. vittatum</i> SC	
Potomac River at Shepherdstown	39.437 -77.800	6				<i>S. luggeri</i> <i>S. jenningsi</i>
Potomac River at Taylors Landing	39.499 -77.767	6				<i>S. luggeri</i>
Unnamed stream at Bent Willow Rd.	39.421 -77.658	1				<i>S. verecundum</i>
Unnamed stream at Rensburg Rd. near C&O Canal	39.495 -77.761	1				<i>S. tuberosum</i> 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.

ACKNOWLEDGMENTS

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