

ECOLOGICAL STUDIES OF BLACK FLIES
IN TWO MARYLAND COUNTIES (DIPTERA:SIMULIIDAE)

by
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COLLEGE PARK, MD.

Thesis submitted to the Faculty of the Graduate School
of the University of Maryland in partial fulfillment
of the requirements for the degree of
Master of Science
1957

APPROVAL SHEET

Title of Thesis: Ecological Studies of Black Flies in
Two Maryland Counties (Diptera:Simuliidae)

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Master of Science, 1957

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ACKNOWLEDGMENTS

The author wishes to express his appreciation to Dr. William E. Bickley for suggesting this problem and giving freely of his time and advice throughout the period of study. The author also expresses his gratitude to Dr. Alan Stone of the Entomology Research Division, U. S. Department of Agriculture, for assistance in identifying specimens and offering timely advice. Dr. C. A. Weigel, Dr. Floyd F. Smith, and many others made observations on black fly adults for which the author is very grateful. The author also wishes to thank Mrs. May Belle Chitwood for her nematode identification.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS.	11
INTRODUCTION	1
REVIEW OF THE LITERATURE	5
MATERIALS AND METHODS.	8
STATION DESCRIPTIONS AND RESULTS OF COLLECTIONS. . .	11
DISCUSSION OF RESULTS.	49
IMPORTANCE OF BLACK FLIES IN THE AREA SURVEYED . . .	59
APPENDIX A. LIST OF COLLECTION STATIONS AND THEIR COORDINATES ON MAP 1.	61
APPENDIX B. STATIONS AT WHICH ADULT FEMALES WERE COLLECTED DURING 1956	63
APPENDIX C. SPECIES OF ADULT FEMALES COLLECTED AT ALL STATIONS DURING 1956.	64
APPENDIX D. STATIONS AT WHICH DIFFERENT SPECIES OF LARVAE WERE COLLECTED DURING 1956 . . .	65
APPENDIX E. SPECIES OF LARVAE COLLECTED, MARCH TO NOVEMBER DURING 1956.	66
APPENDIX F. REPORTS OF BLACK FLY ACTIVITY DURING MAY AND JUNE 1957 AT SILVER SPRING. . .	67
LITERATURE CITED	69
MAP 1.	Pocket

INTRODUCTION

Black flies have been recorded as notorious pests of man and animals for many years. They are annoying because of their biting and crawling habits. Only the adult female is troublesome. The males are seldom seen or collected. These insects belong to the family Simuliidae and may be recognized by their small size, stout bodies, short legs, and a humped appearance due to the arching of the thorax. Because of this characteristic they are sometimes called buffalo gnats.

Stone and Jamnback (1955) list 23 species as occurring in New York State. Most of the 23 species collected in New York may be found over the northeastern part of the United States.

Running water is necessary for the development of the larvae of all North American black flies. The egg-laying habits of most species have not been studied. Generally the female lays 150 to 400 eggs which are deposited singly or in masses in the water. The incubation period varies, depending on the species, from 2.5 days to more than 7 months (Stone and Jamnback, 1955).

The larvae attach themselves upon hatching to substrata such as rocks, leaves or other plant materials by means of thoracic prolegs. The body is then moved about until the sucker-like anal disc can be attached, and a more or less permanent attachment takes place. The larvae pass through six molts and when mature range from 5 to 12 mm. in length depend-

ing on the species (Matheson, 1950). Pupae are found in the same locations as are larvae. Silken pupal cases are woven by the larvae. The length of the pupal stage ranges from two days to three weeks, depending on the species and climatic conditions (Stone and Jamnback, 1955).

Adults have been kept alive for 30 days (Davies, 1953), but in nature some species probably live for longer periods.

The Department of Entomology of the University of Maryland received several calls during the summers of 1954 and 1955 from citizens in parts of Prince George's and Montgomery Counties concerning disturbances caused by small flying insects. These pests while primarily causing concern by their habit of swarming around the head, crawling into the ears, nose, and eyes, were occasionally reported to cause serious difficulty by their bites.

Partly as a result of these complaints a study of the problem was undertaken. At least some of the insects were known to be black flies. Consultation with Dr. Alan Stone at the U. S. National Museum indicated that the great majority of the pests would be black flies, and a survey program was planned with the following objectives in mind:

1. To identify adult black flies and other small flies and gnats that are pests of man primarily because they swarm about the head and get into the eyes, ears, and nose. This study was not to include Culicoides spp.

2. To determine the geographical distribution of these flies in metropolitan Prince George's and Montgomery Counties.

3. To discover as many breeding places as possible.

4. To correlate insofar as possible the physical, chemical and biological nature of larval habitats with larval populations.

5. To obtain records of seasonal distribution and information on life history and habits of various species.

A map of the area to be surveyed was secured and a number of stations selected throughout the counties where black fly larvae might be found. Stations were also selected at which samples of adult populations could be made. These collections were to be made at frequent intervals. As the season progressed new stations were to be added and those found to be unproductive would be eliminated.

The first field trip in 1956 for survey purposes was made to the Patuxent Research Refuge on March 6. Field collection trips continued throughout the spring, summer and fall, the last one being made on November 5th. During the 1956 season 186 different larval observations were made at 35 stations. Adult black flies were collected at 22 stations and 215 observations were made on flying habits of the various species. Map 1 shows the location of the various collecting stations. These are also listed in Appendix A and their coordinates and other aids to location are given.

Early field work in 1957 was concentrated on the collection station at Great Falls, Maryland so that more exact details of the seasonal history of the main pest species might be ascertained. In June, however, routine collection points

were again set up for the collection of larvae and adults throughout the area involved. As of July 1, 1957, 50 different observations on larvae had been made during the first part of the 1957 season at 14 locations, and adult flies were collected at 6 stations and 24 observations were made on flying habits of the adult species.

REVIEW OF THE LITERATURE

Matheson (1950) stated that the family Simuliidae has been rudely treated by the taxonomists. Apparently no two authors have treated the classification of this family in exactly the same manner.

Malloch (1914) published a taxonomic paper on black flies using mainly material which had been gathered in connection with a pellagra investigation in North and South Carolina in 1912. He listed in his bibliography the principal papers dealing with the life histories of black flies. In 1927 Dyar and Shannon published The North American Two-Winged Flies of the Family Simuliidae. This publication was based on the material used by Malloch plus additional material collected up to the time of publication of their bulletin. Forty-seven species were included in this work.

Twinn (1935) studied the black flies of Eastern Canada. He reported on 23 species, 12 of which were new and all but two of which had been unreported from Canada by Dyar and Shannon (1927). This work contains an excellent bibliography of this family.

Underhill (1944) studied black flies that feed on turkeys in Virginia and found Simulium jenningsi Malloch (as S. nigroparvum Twinn) in 28 counties and breeding in 37 streams. S. jenningsi, the main pest species recorded in the area covered in the survey reported herein, was found by Underhill

in Virginia as far east as Richmond, but was more abundant in the mountain and foothill region. Underhill did not conduct surveys in the Potomac River area.

Nicholson and Mickel (1950) undertook a study of the black fly fauna of Minnesota since this group had been relatively unworked in that region. A thorough study of the adult forms found in Minnesota was published.

Mention of a problem in nomenclature should be included at this point. Simulium jenningsi was first described by Malloch (1914). S. nigroparvum Twinn was synonymized with S. jenningsi by Stone (1949). Nicholson and Mickel (1950) described S. jenningsi luggeri as a new subspecies of S. jenningsi. Stone and Jamback (1955) failed to find S. jenningsi luggeri in New York. They apparently did not recognize the two subspecies. The author discusses the present taxonomic status of these forms along with his own observations on their biology in the section entitled Discussion of Results.

Stains and Knowlton (1943) published a taxonomic distributional study of the black flies of the Western United States.

Two publications were used extensively by the writer in this study and are without question the most complete and accurate taxonomic works available dealing with the black fly fauna in the Eastern United States. These are The Black Flies of New York State by Alan Stone and Hugo A. Jamback (1955) and An Illustrated Key to the Blackfly Larvae Commonly Collected in New York State by Hugo Jamback (1955).

Since this work was primarily an ecological study no

morphological information is included herein. Important anatomical studies include those by Krafchick (1943) and Nicholson (1945) on mouthparts, Freeman (1950) on the male genitalia, and Puri (1925) on the larvae and pupae.

Many useful ideas regarding style for presentation of data and field techniques were obtained from a detailed ecological study of Alaskan black flies conducted by Sommerman, Sailer, and Esselbaugh in 1948 (Sommerman, Sailer, and Esselbaugh 1955).

Perhaps the most outstanding work ever published on this group is the treatise, The Black Flies (Diptera, Simuliidae) of Guatemala and Their Role as Vectors of Onchocerciasis, by Herbert Dalmat (1955).

MATERIALS AND METHODS

The first item secured for use in this study was a U. S. Department of the Interior, Geological Survey map of Washington and Vicinity (Scale, 2 inches = 1 mile). This map shows in detail all the creeks and streams in the area. A pair of hip boots is necessary for this type of survey work. A camera bag three inches wide, nine inches long, and eight inches high with a side pocket and shoulder strap, was used to carry vials and forceps used for collecting. For adult collections an insect net with a 12-inch mouth was used.

In the field adults and larvae were preserved in 70 per cent alcohol and identified in the laboratory under a stereoscopic microscope. Dentist drills, with sharpened points, mounted in small round dowels were used in manipulating specimens into correct position for microscopic study.

From the map a series of stations was selected for larval and adult collection sites. Each point visited was given a number. These sites were approached by automobile as nearly as possible, and the remainder of the distance was covered on foot. Black fly larvae are found only in rapidly flowing water, and no exceptions to this phenomenon were observed. Larvae were found attached to stones, plants, grasses, sticks, leaves, moss, and debris. Pupae were also recovered from these objects. Specimens of larvae and pupae were picked off the object to which they were attached by small forceps

and placed in vials of 70 per cent alcohol.

Adult flies generally were captured by sweeping around the collector's head with a net as the gnats swarmed. A few of the biting species were collected by slipping a vial of alcohol over them as they tried to bite.

Several hundred cards were used for the purpose of cataloging adult and larval collections. As identifications were made the information as to species, field conditions, and location of capture was recorded on these cards. Thus it is possible to arrange the collections by species, by date, or by locality, whichever system is desired.

The problem of recording the degree of infestation of larvae in a stream is difficult. Some authors prefer to record the maximum number of larvae that can be found in a square inch. This leads to a false impression in most cases since it is not uncommon to find a heavy infestation of larvae in a single spot; whereas the overall picture is entirely different, there being very few larvae throughout the stream bed. The author therefore has used the following system:

None - No larvae found.

Trace - One or two larvae collected at the station.

Few - No difficulty was encountered in finding larvae, but they were few and scattered.

Medium - Several larvae present over the entire area.

Heavy - A heavy concentration of larvae; many present over the entire area. Objects more or less covered with larvae.

Saturated - Object to which larvae attached almost or completely invisible because of dense population.

The same system was used to record pupal densities.

Adult collections were made primarily to determine the species causing a nuisance. Usually the degree of infestation of adults is the number that can be collected over a period of time. Since the majority of flies collected was a species which does not bite man the only way to collect them was to sweep around the head with a net. By counting the number of flies captured in each sweep it was possible to determine a light, medium, or heavy infestation. One or two flies per sweep was considered a light infestation (referred to as few); two to six, a medium infestation; and more than six, heavy. In order for an infestation to be recorded as heavy, however, it was necessary for the flies to be present for a continuous period of five to 10 minutes in large numbers.

STATION DESCRIPTIONS AND RESULTS OF COLLECTIONS

In the following pages a description of each of the larval stations is given along with a summary of the various species collected (if any) together with other pertinent information. It should be noted at this point that, with the exception of the Potomac River, all the streams studied are less than 30 feet in width and generally shallow.

Reports of collections at each station are made using the scheme denoting the degree of infestation described on pages 9 and 10. Dates as given indicate visits or attempts to collect. Unless otherwise noted collection records refer to larvae. Unless otherwise noted pupae collected with larvae are the same species as the larvae. Collections were made by the author unless indicated otherwise. Unless stated otherwise references to Simulium jenningsi in the collection records which follow refer to the nominal subspecies of Nicholson and Mickel (1950).

Station 1 is the concrete overflow spillway from Snowden Pond on the Patuxent Research Refuge near Laurel. Flow down the spillway at the time collections were made was two feet wide and about an inch deep and fairly rapid.

Collections in 1956 at Station 1:

April 27, none.

October 15, medium Simulium vittatum Zetterstedt;
few S. decorum Walker.

Station 2 is a small swift stream, several inches deep and several feet wide, originating at an overflow from Wide-water, a large artificial lake caused by the widening of the Chesapeake and Ohio Canal about one mile below Great Falls. The area where collections were made extended about 100 feet downstream from the spillway. This station is dry at the present time (July 1957) due to a break in the dike which allows most of the water to escape from the lake.

Collections in 1956 at Station 2:

- March 11, medium Simulium vittatum; medium pupae.
- April 17, medium S. vittatum; medium pupae.
- May 4, saturated S. vittatum; heavy pupae.
- May 6, saturated S. vittatum; heavy pupae.
- May 18, trace S. vittatum; few pupae.
- May 25, none S. vittatum; trace pupae.
- June 10, none.

Station 3 is a section of a stream called Rock Run just north of where it flows under MacArthur Blvd. It is about 10 feet wide and one foot deep and tumbles over large rocks and swift shallows. Collections were made here all summer for a distance of several hundred feet upstream from MacArthur Blvd. Six species were taken at this station.

Collections in 1956 at Station 3:

- March 21, few Prosimulium species; trace pupae, Simulium vittatum.
- March 25, none.
- April 17, few Prosimulium magnum Dyar and Shannon; trace

S. tuberosum (Lundstroem); trace S. decorum.

April 28, medium S. venustum Say; few pupae; few pupae,

S. decorum; trace pupae, P. magnum.

May 4, medium S. tuberosum; few S. parnassum Malloch; medium

pupae, S. venustum complex (Stone and Jamnback 1955);

trace pupae, P. magnum.

May 18, medium immature and unidentified; trace S. vittatum;

trace pupae, S. venustum complex.

May 25, heavy S. tuberosum; few pupae, S. venustum complex.

June 9, medium S. tuberosum; medium pupae.

June 24, few S. tuberosum; trace pupae.

July 21, none (after torrential rains and flash flood).

August 12, few S. tuberosum; few pupae.

August 22, few S. tuberosum; few pupae.

August 27, few S. tuberosum; few pupae.

September 5, few S. tuberosum; trace pupae.

September 16, few S. tuberosum; few pupae.

September 25, few S. tuberosum; few pupae.

October 7, few S. tuberosum; few pupae.

October 14, few S. tuberosum; few pupae.

October 24, trace S. tuberosum; trace pupae.

November 5, trace S. tuberosum.

Collections in 1957 at Station 3:

June 11, trace S. tuberosum; trace pupae.

June 17, few S. tuberosum; collection by R. S. Chandler.

June 21, few S. tuberosum; trace pupae; collection by R. S.

Chandler.

June 25, few S. tuberosum; trace pupae, S. tuberosum;

trace pupae, S. vittatum; collection by R. S. Chandler.

Station 4 is located along the east bank of the Potomac River just south of the first rapids (dam) below Seneca. Only one check was made here because of the relatively long distance from suburban areas.

Collections in 1956 at Station 4:

March 30, none.

Station 5 is north of Duvall Bridge along the Patuxent River in the Patuxent Research Refuge. The river in this region is rather sluggish, but there are occasional rapids.

Collections in 1956 at Station 5:

April 27, none.

May 26, none.

Station 6 is along the Patuxent River stream bed for about 100 yards, one-quarter mile below Brighton Dam near Ashton. The river is less than 20 feet wide and several feet deep with occasional rapids. Since this station was also a long distance from heavily populated areas it was abandoned as a collection point in 1956.

Collections in 1956 at Station 6:

April 9, saturated Simulium vittatum; saturated pupae.

Collections in 1957 at Station 6:

June 17, heavy S. vittatum; heavy pupae.

Station 7 is located north along Paint Branch about one-half mile above where it crosses Maryland Route 196. This was an excellent collection point, and the location was utilized

well into the summer of 1956 until construction work on a new highway bridge caused it to be dropped. Most of the collections made here were taken at a point where the stream bed was solid rock for several feet and then turned into a series of rapids for about fifteen feet. The creek was about 30 feet wide and one foot deep above and below this point. The main collection point was about half a mile upstream so the author walked up the creek bed examining material until reaching the main collecting station. Just downstream from the main collecting spot a small branch enters the main stream. Silt and mud coming from this branch along with heavy mica content in the sand bottom were thought to be the main factors in preventing larvae from developing below the main collection point.

Collections in 1956 at Station 7:

April 9, trace Prosimulium hirtipes (Fries).

April 23, few Simulium tuberosum; few S. venustum; few P. magnum; trace pupae, P. hirtipes.

April 27, medium S. venustum; medium S. tuberosum; few P. magnum; medium pupae, S. venustum complex.

May 5, few S. tuberosum; few pupae, S. venustum complex.

May 12, few S. tuberosum; few pupae, S. venustum complex.

May 19, few S. tuberosum; few pupae.

June 6, few S. tuberosum; trace pupae.

June 17, few S. tuberosum.

June 24, medium S. tuberosum; few pupae.

July 3, few S. tuberosum; few pupae.

July 12, few S. tuberosum.

July 28, few S. tuberosum; trace pupae.

August 4, few S. tuberosum; few pupae.

August 19, medium S. tuberosum.

Station 8 is a rather long collection station starting at the bridge where Maryland Route 183 crosses the Northwest Branch and continuing upstream for about one-half mile to the first fork. The station then runs another 100 yards or so up the small stream which is the left fork of the division when facing north. The Northwest Branch, while usually maintaining a width of 20 feet or more and a depth of several feet, sometimes changes to rapids or wide deep pools. Just a hundred feet or so from the bridge there is a small dam from which larvae were collected. The stream coming in at the fork is only a few feet wide and one or two inches deep, with occasional deeper pools. A collection made from the smaller stream (fork) or from the dam will be so indicated after the date.

Collections in 1956 at Station 8:

April 10, fork, few Simulium tuberosum; few Prosimulium magnum.

April 27, trace P. magnum; few S. tuberosum; medium S. venustum;

few pupae, S. venustum complex; dam, few S. venustum; few

P. magnum.

May 5, few S. venustum; few pupae, S. venustum complex.

May 12, few S. vittatum; few pupae.

May 19, medium S. vittatum; few pupae; few S. tuberosum.

May 26, medium S. vittatum; medium pupae; medium S. tuberosum;
medium pupae.

June 6, medium S. tuberosum; few pupae; trace S. vittatum.

June 24, stream swollen from heavy rains, too high to collect.

July 3, medium S. tuberosum; few pupae.

July 28, few S. tuberosum; few pupae.

August 4, few S. tuberosum; few pupae; trace S. vittatum.

August 19, few S. tuberosum; few pupae; trace S. vittatum.

September 4, medium S. tuberosum; few pupae.

September 15, heavy S. tuberosum; medium pupae; few S. vittatum;
medium pupae.

September 24, medium S. tuberosum; few pupae; few S. vittatum.

October 1, few S. tuberosum; few pupae.

Collections in 1957 at Station 8:

June 12, few S. vittatum; collection by R. S. Chandler.

June 21, few S. tuberosum; few pupae; collection by R. S.
Chandler.

June 26, few S. tuberosum; few pupae; collection by R. S.
Chandler.

Station 9 is just below the dam and filtration plant at Burnt Mills, Maryland where the Northwest Branch drops over a series of rapids and falls, then levels off to a swift stream 20 feet wide and a foot or two deep.

Collections in 1956 at Station 9:

April 10, none.

April 23, few Simulium tuberosum.

Station 10 is located along the east bank of the Potomac from opposite the point at which MacArthur Blvd. turns north from paralleling the C. & O. Canal to the base of Great Falls. The river in this section is very deep and has no rapids.

Collections in 1956 at Station 10:

April 17, none.

Station 11 is a section of a small stream several hundred feet upstream above the small pond which is due west of the farm buildings at the University's Plant Research Farm near Fairland, Maryland. This stream is only several feet wide at its peak in the spring and has a fairly swift flow in spots over small rapids. As summer approaches, the rate of flow dwindles to a trickle and black fly breeding stops.

Collections in 1956 at Station 11:

April 14, trace Prosimulium hirtipes; trace Simulium venustum; trace Cnephia mutata (Malloch); few pupae, unidentified.

April 23, medium S. venustum; few S. tuberosum; few P. hirtipes; few pupae, unidentified.

April 27, medium S. venustum; few S. tuberosum; few P. hirtipes; few pupae; few pupae, S. venustum complex.

May 12, few S. venustum; few pupae.

May 19, few S. venustum; few pupae, S. venustum complex.

May 26, few S. tuberosum; few pupae, S. venustum complex.

June 7, few S. tuberosum; few pupae, S. venustum complex.

June 24, none.

July 2, none.

July 12, trace unidentified.

September 7, none.

Collections in 1957 at Station 11:

March 30, medium S. venustum; trace pupae; medium P. hirtipes; trace pupae.

April 13, medium S. venustum; few pupae; few P. hirtipes;
trace S. tuberosum; trace C. mutata.

April 28, medium S. venustum; medium pupae.

June 12, few S. tuberosum; collection by R. S. Chandler.

June 26, none.

Station 12 is located on the east side of the Potomac River just below Great Falls. When the water level drops in the spring, flow through this area stops and the area becomes a pond.

Collections in 1956 at Station 12:

April 20, none.

Station 13 is located north for several hundred yards along the stream where Rock Creek crosses Maryland Route 28. The time spent searching for specimens in such a poor breeding area did not justify maintaining this location as a collection point.

Collections in 1956 at Station 13:

April 20, none.

Station 14 is located along Beech Drive near Kensington. Rock Creek, in the region of this collection station, is a slow, winding, generally muddy stream. The collection point is one of the less frequent locations where rapids are found in this section.

Collections in 1956 at Station 14:

April 20, none.

May 19, few Simulium vittatum.

Collections in 1957 at Station 14:

June 14, trace S. vittatum.

Station 15 is a by-pass, four feet wide and from one to 12 inches deep, which permits water to flow around Lock 18 along the C. & O. Canal, just below Great Falls. The flow is swift and usually tumbles over large rocks in the stream bed. This station was visited continuously throughout the season and many interesting observations were made here.

Collections in 1956 at Station 15:

April 20, few Simulium tuberosum.

April 28, medium S. vittatum; trace S. decorum.

May 4, medium S. vittatum; medium pupae.

May 11, medium S. vittatum; few pupae.

May 18, medium S. vittatum; medium S. decorum; trace S. tuberosum.

May 25, heavy S. vittatum; few pupae; few S. decorum; few pupae; trace pupae, S. venustum complex.

June 5, saturated S. vittatum; few pupae; heavy S. decorum.

June 10, saturated S. vittatum; saturated S. decorum.

June 13, saturated S. decorum; trace S. vittatum.

June 24, medium S. vittatum; few pupae; trace pupae, S. decorum.

June 28, medium S. vittatum; few pupae; trace S. decorum; trace pupae.

July 8, few unidentified.

July 28, none, canal drained for cleaning.

August 5, none, canal still dry.

August 22, none, canal full again and water at station.

August 27, trace S. vittatum.

September 5, few S. jenningsi; few pupae; few S. vittatum;
few pupae; few S. tuberosum; few pupae.

September 12, medium S. vittatum; trace pupae; medium
S. jenningsi; trace pupae; medium S. tuberosum.

September 18, medium S. vittatum; few pupae; few S. decorum;
few S. jenningsi.

September 25, medium S. vittatum; medium pupae; few pupae,
S. decorum.

October 1, medium S. vittatum; few pupae; trace S. decorum.

October 5, few S. vittatum; few pupae; few pupae, S. decorum.

October 14, heavy S. vittatum; few pupae; trace S. tuberosum.

October 24, medium S. vittatum; few pupae; few S. decorum; few
pupae; trace pupae, S. tuberosum.

November 5, medium S. vittatum; few pupae; trace S. decorum;
trace pupae; trace S. jenningsi.

Collections in 1957 at Station 15:

April 16, few S. decorum; few S. vittatum.

April 26, medium S. vittatum; medium pupae.

May 6, few S. vittatum; few pupae; few S. decorum.

May 16, medium S. vittatum; few pupae; medium S. decorum.

May 22, medium S. vittatum; trace pupae.

June 11, heavy S. vittatum; trace pupae; trace S. decorum;
trace pupae.

June 14, medium S. vittatum; few pupae; trace pupae, S. decorum;
collection by R. S. Chandler.

June 17, heavy S. vittatum; few pupae; few S. decorum;

collection by R. S. Chandler.

June 21, heavy S. vittatum; trace pupae; heavy S. decorum;
trace pupae; collection by R. S. Chandler.

June 25, heavy S. decorum; trace pupae; heavy S. vittatum;
few pupae; collection by R. S. Chandler.

Station 16 is located north for one mile along the Northwest Branch from where it flows under New Hampshire Avenue. The stream along this section is steady, with a few rapids, but is generally about 20 feet wide and one foot deep with no vegetation.

Collections in 1956 at Station 16:

April 27, few Simulium tuberosum.

Collections in 1957 at Station 16:

June 13, few S. vittatum; few pupae; few S. tuberosum; trace pupae, S. venustum complex; collection by R. S. Chandler.

Station 17. The Potomac River at Great Falls between the dam and the falls divides into several branches which flow through a number of islands. One of these branches, the second from the east bank of the river, is easily reached and is an excellent collecting point. The flow through this spot is usually fairly swift with a few rapids. The width and depth vary with the amount of water coming down the river, but it is almost always shallow enough to permit wading. This station is described more fully in the discussion of results.

Collections in 1956 at Station 17:

April 20, none.

April 28, none.

May 4, few Simulium jenningsi.

May 11, few S. jenningsi; few pupae.

May 18, few S. jenningsi.

May 25, few S. jenningsi; few pupae; few S. tuberosum; few S. vittatum; few pupae; and trace pupae, S. venustum complex.

June 5, heavy S. jenningsi; heavy pupae; trace S. vittatum.

June 10, saturated S. jenningsi; heavy pupae; trace pupae, S. vittatum.

June 13, few S. jenningsi; few pupae.

June 16, few S. jenningsi; few pupae; trace S. vittatum.

June 24, few S. jenningsi; few pupae.

June 28, few S. jenningsi; few pupae; trace S. vittatum.

July 8, few S. jenningsi; few pupae.

July 17, medium S. jenningsi.

July 21, river too high to permit collections.

July 29, heavy S. jenningsi; few pupae.

August 5, heavy S. jenningsi; heavy pupae.

August 8, river too high to permit collections.

August 12, few S. jenningsi.

August 22, few S. jenningsi.

August 27, medium S. jenningsi; few pupae.

September 5, few S. jenningsi; trace pupae.

September 12, heavy S. jenningsi; trace pupae.

September 18, medium S. jenningsi; few pupae.

September 25, few S. jenningsi; few pupae.

October 1, trace S. jenningsi.

October 5, few S. jenningsi; few pupae.

October 14, trace S. jenningsi.

October 24, none.

Collections in 1957 at Station 17:

April 16, none.

April 26, few S. jenningsi.

April 30, few S. jenningsi; few pupae; few S. vittatum; few pupae; few pupae, S. jenningsi luggeri.

May 6, few S. jenningsi; few pupae; trace pupae, S. jenningsi luggeri.

May 16, saturated S. jenningsi; few pupae; trace pupae, S. jenningsi luggeri; few pupae, S. vittatum.

May 22, saturated S. jenningsi; few pupae.

May 27, saturated S. jenningsi; few pupae.

May 28, heavy S. jenningsi; few pupae.

May 29, medium S. jenningsi; heavy pupae.

May 30, medium S. jenningsi; medium pupae.

June 10, trace S. jenningsi; few pupae.

June 11, trace S. jenningsi; few pupae.

June 14, few S. jenningsi; few pupae; collection by R. S. Chandler.

June 17, few S. jenningsi; few pupae; few S. vittatum; collection by R. S. Chandler.

June 21, heavy S. jenningsi; few pupae; collection by R. S. Chandler.

June 25, few S. jenningsi; few pupae; collection by R. S. Chandler.

June 28, none.

Station 18 is about 100 yards upstream from where Cabin John Creek crosses River Road. Here the creek flows over a series of rapids dropping five feet or more in elevation. These rapids are about four feet wide. The creek above and below the falls is about 20 feet wide and several feet deep.

Collections in 1956 at Station 18:

May 4, few Simulium vittatum; few pupae; few pupae, S. venustum complex.

May 25, medium S. vittatum; few pupae.

July 21, creek too high to permit collections.

August 5, few S. vittatum; trace pupae; trace S. tuberosum; trace pupae.

September 9, medium S. vittatum; few pupae; few S. tuberosum.

October 7, few S. vittatum; trace pupae.

October 14, few S. vittatum; trace pupae.

October 24, trace S. vittatum; trace pupae.

November 5, few S. vittatum; trace pupae.

Collections in 1957 at Station 18:

June 13, few S. vittatum; few S. tuberosum; collection by R. S. Chandler.

June 25, few S. tuberosum; trace pupae; collection by R. S. Chandler.

Station 19 is where Little Falls Branch flows under Massachusetts Avenue. It looks like a good breeding area for black fly larvae, but on a visit here on May 4 the stream was found full of trash and smelled of gasoline and was dropped

as a collection point.

Collections in 1956 at Station 19:

May 4, none.

Station 20 is located where Minnehaha Branch, a very small stream, flows under Massachusetts Avenue.

Collections in 1956 at Station 20:

May 4, none.

Station 21 is located near Glen Echo on the east bank of the Potomac River. The river is broken by many small islands at this point and it is possible beginning in late May to wade in the river and make collections in this area. There are occasional rapids between islands and the waterwillow (see Discussion of Results) grows in the more shallow spots.

Collections in 1956 at Station 21:

March 11, inaccessible due to high water.

May 4, inaccessible due to high water.

May 18, few Simulium vittatum; few pupae; few S. jenningsi; few pupae; trace S. fibrinflatum Twinn; trace pupae; few pupae, S. jenningsi luggeri.

May 29, few S. vittatum; few pupae; few S. jenningsi; few pupae; trace pupae, S. venustum complex; trace pupae S. jenningsi luggeri.

June 16, few S. vittatum; few pupae; few S. jenningsi; few pupae; trace pupae, S. venustum complex.

September 16, few S. jenningsi; few pupae.

Station 24 is downstream several hundred feet along a small creek which passes under Maryland Route 193 just south

of Metzert Road.

Collections in 1956 at Station 24:

May 4, none.

Station 25 is a spillway, just north of Lock 20 and directly south of the entrance of the Washington water aqueduct, down which the overflow from the C. & O. Canal moves to the Potomac.

Collections in 1956 at Station 25:

May 11, heavy Simulium vittatum; heavy pupae.

May 25, heavy S. vittatum; heavy pupae; trace S. venustum.

Station 26 is the stream bed of Cabin John Creek north for several hundred yards from where it flows under MacArthur Blvd. The creek is 20 feet wide and several feet deep for the first one-quarter mile upstream and then rapids develop.

Collections in 1956 at Station 26:

May 11, few Simulium vittatum; few pupae.

May 18, medium S. vittatum; few pupae.

June 9, few S. vittatum; trace S. tuberosum.

June 23, few unidentified, after heavy rains.

July 21, none, after heavy rain.

Station 27 is Little Paint Branch which after passing under Powder Mill Road widens into a slow moving stream, about 15 feet wide varying in depth from a foot to several inches. Two hundred feet downstream this type of situation ends and the flow turns into a series of rapids.

Collections in 1956 at Station 27:

May 26, few Simulium tuberosum; trace S. vittatum; trace pupae,

S. venustum complex.

June 7, medium S. tuberosum; few S. vittatum; few pupae,

S. venustum complex.

July 3, medium S. tuberosum; trace pupae.

July 12, medium S. tuberosum; trace pupae.

August 4, few S. tuberosum; few pupae.

August 19, medium S. tuberosum; few pupae.

September 5, medium S. tuberosum; few pupae.

September 15, medium S. tuberosum.

September 24, medium S. tuberosum; few pupae.

October 7, few S. tuberosum; few pupae.

October 28, few S. tuberosum.

Collections in 1957 at Station 27:

June 13, few S. tuberosum; collection by R. S. Chandler.

June 21, few S. tuberosum; few pupae; collection by R. S. Chandler.

June 26, few S. tuberosum; few pupae; collection by R. S. Chandler.

Beginning with the August 19 collection in 1956 an increasing number of larvae of each collection at this station was found to be parasitized by a nematode of the genus Paramermis. The table below shows the increasing number of parasites in collections throughout the season.

<u>Date</u>	<u>S. tuberosum</u> <u># larvae collected</u>	<u>S. tuberosum larvae</u> <u>parasitized</u>
May 26	11	0
June 7	25	0
July 3	medium	0
July 12	60	0
August 4	16	0
August 19	medium	1
September 5	70	2
September 15	heavy	1
September 24	62	24
October 7	25	24
October 28	20	20

It is doubtful whether larvae could survive after being infested with these worms since they take up the entire abdomen. They are probably an important factor in maintaining natural control of Simulium tuberosum later in the season.

Station 28 is Paint Branch at Metzert Road. Here the stream is 30 feet wide and a few inches deep. This station was considered to be of little importance, and was dropped as a collection point.

Collections in 1956 at Station 28:

June 7, few Simulium vittatum.

Station 29 is along the Northeast Branch near where it flows under Calvert Road in College Park.

Collections in 1956 at Station 29:

June 9, trace Simulium vittatum.

Collections in 1957 at Station 29:

June 14, few S. vittatum; collection by R. S. Chandler.

Station 30 is located among the group of islands along the east bank of the Potomac next to the C. & O. Canal Lock 8. It is possible to wade out in the shallows at this point and

collect from the waterwillow plants which grow in profusion in this region.

Collections in 1956 at Station 30:

April 13, none.

June 23, few pupae, Simulium jenningsi.

Station 31 is a series of rapids, below a large section of stream 30 feet wide and up to 10 feet deep on the Patuxent River near Ashton.

Collections in 1956 at Station 31:

July 4, heavy Simulium vittatum; few pupae.

Station 32 is the Potomac River at Stubblefield Falls. There is a series of rapids here several hundred feet in length. Waterwillow grows by the acre on flat gravel beds which are covered with water early in the spring and are ideal for black fly larvae. This station is not inaccessible but can be reached only by walking. Since the walking distance is about 1-1/2 miles one way, the time element becomes an acute problem. During the early spring a tremendous number of flies probably develop in this area.

Collections in 1956 at Station 32:

July 8, trace Simulium jenningsi.

August 11, trace S. jenningsi.

August 29, medium S. jenningsi; medium pupae.

Station 33 is Sligo Creek at U.S. 29. The stream here is normally a slight trickle a few feet wide and several inches deep.

Collections in 1956 at Station 33:

October 15, none.

Station 38 is along the east bank of the Potomac River south of Herzog's Island. No likely breeding sites were located in a survey of this region.

Collections in 1956 at Station 38:

April 2, none.

Station 39 is the concrete overflow spillway on the southwest corner of Greenbelt Lake.

Collections in 1956 at Station 39:

May 13, none.

Station 40 where Paint Branch flows under Powder Mill Road appears to be a good breeding site. Since little was collected here the station was dropped.

Collections in 1956 at Station 40:

May 12, trace unidentified.

June 7, none.

Station 44 is the Potomac River south of Chain Bridge to Key Bridge. An all-day survey by motor boat was made of this area and no breeding spots were located. The river moves too slowly in this region and no rapids are present.

Collections in 1956 at Station 44:

May 30, none.

Station 45 is the Anacostia River between Riverdale Road and Peace Cross.

Collections in 1957 at Station 45:

June 14, none.

Station 46 is where Paint Branch flows under U.S. 1.

The creek here is 20 feet wide and varies in depth from inches to several feet.

Collections in 1957 at Station 46:

June 17, trace unidentified; collection by R. S. Chandler.

Station 49 is Rock Creek at Viers Mill Road.

Collections in 1957 at Station 49:

June 21, few Simulium vittatum; trace pupae; collection by R. S. Chandler.

Observations on adult activities were made at all larval collection points plus several additional sites. In order to capture an adequate sample and make an accurate determination as to the degree of infestation a period of about five minutes was spent at each location. Flies were collected by sweeping an insect net around the head. As the flies crawled up the side of the net to escape they were counted and forced into vials of 70 per cent alcohol.

Flies were also collected by sweeping across the face with a handkerchief in the palm of the hand. This method was not at all satisfactory, and was used only when a net was not available. Biting flies were collected by slipping a vial over them as they prepared to feed.

Since the major pest in this area, Simulium jenningsi, does not normally feed on man, it was necessary to establish a system, other than by biting collections to determine population densities. Three degrees of abundance of flies were arbitrarily established and are explained on page 10.

Each adult station is described below and a summary of

the collections made is given. Adult stations in close proximity to larval collection stations are given the same number as the larval station. All flies collected by sweeping were females with one exception noted.

Adult Station 1 is the Patuxent Research Refuge. Flies were observed at several substations on the Refuge. Adult Substation 1a was located in the wooded area around Duvall Bridge. Adult Substation 1b was in the open area north of the Administration Building.

Collections in 1956 at Adult Station 1:

March 6, Substation 1a, none.

April 7, Substation 1a, none.

April 27, Substation 1a, few Prosimulium hirtipes (one specimen).

May 26, Substation 1a, none.

May 29, Substation 1b, few Simulium venustum (2 specimens); collection by Robert Evans.

October, Substation 1b, few unidentified.

Adult Station 2 is the trail along the C. & O. Canal from the parking area where MacArthur Blvd. turns north from the canal to Larval Station 2. The trail is bordered on the west by woods and on the east by Widewater. Flies were observed in the wooded area around Larval Station 2.

Collections in 1956 at Adult Station 2:

March 11, none.

May 4, none.

May 6, none.

May 18, heavy Simulium jenningsi.

May 25, none.

June 10, medium S. jenningsi.

Adult Station 3 is located where MacArthur Blvd. crosses Rock Run. There is a five-foot strip of grass between the woods and MacArthur Blvd. at this station. Across the road the area is largely wooded.

Collections in 1956 at Adult Station 3:

March 21, none.

March 25, none.

April 12, none.

April 28, none.

May 8, heavy Simulium jenningsi.

May 25, medium S. jenningsi.

June 9, none.

June 24, heavy S. jenningsi.

July 21, heavy S. jenningsi.

July 29, none.

August 12, medium S. jenningsi.

August 22, medium S. jenningsi.

August 27, none.

September 5, none.

September 16, few S. jenningsi.

September 25, heavy S. jenningsi.

October 7, heavy S. jenningsi.

October 14, none.

October 24, heavy S. jenningsi; few S. vittatum (one specimen).

November 5, medium S. jenningsi.

Collections in 1957 at Adult Station 3:

June 11, medium S. jenningsi.

June 21, medium S. jenningsi; collection by R. S. Chandler.

Adult Station 4 is along the east bank of the Potomac River just south of Seneca.

Collections in 1956 at Adult Station 4:

March 30, none.

Adult Station 6 is the area along the Patuxent River for one-half mile south of Brighton Dam.

Collections in 1956 at Adult Station 6:

April 9, none.

Collections in 1957 at Adult Station 6:

June 17, few Simulium vittatum (one specimen); collection by R. S. Chandler.

Adult Station 7 is the area where Paint Branch flows under Maryland Route 196. This region is heavily wooded section, and only at the larval collection point is there any grass.

Collections in 1956 at Adult Station 7:

April 9, none.

April 23, none.

April 27, few Simulium venustum (one specimen).

May 5, few S. venustum (one specimen).

May 12, few S. venustum (one specimen).

May 19, few S. venustum (one specimen); few S. jenningsi.

May 26, few S. jenningsi.

June 6, few unidentified.

June 17, none.
June 24, none.
July 3, few unidentified.
July 12, none.
July 28, none.
August 4, none.
August 19, none.

Adult Station 8 is along the larval collection station north of where the Northwest Branch flows under Maryland Route 183. While flies were watched for throughout this area, they were usually found only in the vicinity of a large sycamore tree near the ball field.

Collections in 1956 at Adult Station 8:

April 10, none.
April 23, none.
April 27, none.
May 5, none.
May 12, none.
May 19, medium Simulium jenningsi.
May 26, few unidentified.
June 6, few S. jenningsi.
June 17, few S. jenningsi.
June 24, heavy S. jenningsi.
July 3, few unidentified.
July 28, heavy S. jenningsi.
August 4, medium S. jenningsi.
August 9, heavy S. jenningsi.

August 19, few (no collections made).

September 4, few (no collections made).

September 15, few S. jenningsi.

September 24, few S. jenningsi.

October 1, none.

Adult Station 9 is along the Northwest Branch for several hundred yards south of the Burnt Mills filtration plant. The area is wooded.

Collections in 1956 at Adult Station 9:

April 10, none.

April 23, none.

Adult Station 10 is along the Potomac River east of the Widewater area of the C. & O. Canal. This is a wooded region, but beds of rock are common.

Collections in 1956 at Adult Station 10:

April 17, none.

Collections in 1957 at Adult Station 10:

April 22, none.

Adult Station 11 is divided into two substations, 11a and 11b. Substation 11a is located in the area around Larval Station 11. A small stream runs through this wooded region and there is an occasional clearing with some grass. Substation 11b is located at the north end of the farm near where Cherry Hill Road meets new U.S. 29. The collection spot is a grass field surrounded by woods on one side and field crops on the other.

Collections in 1956 at Adult Station 11:

- April 1, Substation 11a, few Prosimulium hirtipes (one specimen)
collection by D. J. Kissinger.
- April 14, Substation 11b, none.
- April 23, Substation 11b, none.
- April 27, Substation 11b, none.
- April 28, Substation 11b, few P. hirtipes (one specimen).
- May 5, Substation 11b, few Simulium venustum (one specimen).
- May 12, Substation 11b, none.
- May 19, Substation 11b, few S. venustum; few S. jenningsi.
- May 26, Substation 11b, few S. jenningsi.
- June 7, Substation 11b, none.
- June 14, Substation 11b, few S. jenningsi; few S. venustum
complex.
- June 15, Substation 11a, few S. jenningsi.
- June 18, Substation 11a, heavy S. jenningsi.
- June 20, Substation 11a, none.
- June 24, Substation 11b, few S. jenningsi.
- July 2, Substation 11b, medium S. jenningsi.
- July 12, Substation 11b, few S. jenningsi.
- August 12, Substation 11a, heavy S. jenningsi; collection by
D. J. Kissinger.
- August 13, Substation 11a, heavy S. jenningsi; collection by
D. J. Kissinger.
- August 26, Substation 11a, heavy unidentified; observer D. J.
Kissinger.
- September 7, Substation 11a, few S. jenningsi.
- October 6, Substation 11b, none.

October 8, Substation 11b, none.

October 9, Substation 11b, none.

Collections in 1957 at Adult Station 11a:

April 13, few Simulium venustum.

April 28, none.

Adult Station 13 is where Rock Creek flows under Maryland Route 28. This area is wooded.

Collections in 1956 at Adult Station 13:

April 20, none.

Adult Station 14 is that section of Rock Creek Park just south of Kensington along Beech Drive. This area is predominantly grassland.

Collections in 1956 at Adult Station 14:

April 20, none.

May 19, few unidentified.

September 15, few unidentified.

Adult Station 16 is the area running north for one mile along the Northwest Branch from New Hampshire Avenue. The stream runs through woods at all times.

Collections in 1956 at Adult Station 16:

April 27, none.

Adult Station 18 is a heavily wooded region where Cabin John Creek flows under River Road.

Collections in 1956 at Adult Station 18:

May 4, none.

May 25, few Simulium jenningsi.

July 21, none.

August 5, few S. jenningsi (collected during drizzle).

September 9, few S. jenningsi.

October 7, medium S. jenningsi.

October 14, none.

October 24, none.

November 5, none.

Collections in 1957 at Adult Station 18:

June 3, few S. jenningsi; collection by R. S. Chandler.

Adult Station 21 is the area between Glen Echo Amusement Park and the Potomac River. This region is largely wooded, but there are some grasslands in the area.

Collections in 1956 at Adult Station 21:

March 11, none.

May 4, none.

May 18, none.

May 29, none.

June 16, none.

August 11, none.

September 16, few unidentified.

Adult Station 25 is the area around Great Falls. Unless noted otherwise collections in this region were made within several hundred feet of the parking area. While woods surround the area, there is an abundance of grassland in this region.

Collections in 1956 at Adult Station 25:

April 17, none.

April 20, none.

April 21, few Prosimulium hirtipes (five specimens); few Simulium vittatum (one specimen); collected by D. J. Kissinger while hiking along C. & O. Canal north of Great Falls.

April 28, few S. venustum; few P. hirtipes; few male and female P. magnum, one specimen each sex.

May 4, none.

May 11, heavy S. jenningsi.

May 18, heavy S. jenningsi.

May 25, medium S. jenningsi; few S. vittatum; few S. decorum (one specimen).

June 10, few S. jenningsi; few S. venustum (in wooded area only).

June 13, medium S. jenningsi; few S. decorum (one specimen).

June 16, none.

June 19, few S. jenningsi; few S. decorum.

June 24, none.

June 28, none.

July 8, few S. jenningsi; collected while collecting larvae from river.

July 17, none.

July 21, none.

July 28, none.

July 29, none.

August 5, none.

August 8, none.

August 12, none.

August 22, none.
 August 27, none.
 September 5, none.
 September 12, few (no collection made).
 September 18, none.
 September 25, few S. jenningsi.
 October 5, few S. jenningsi.
 October 14, heavy S. jenningsi.
 October 24, few S. jenningsi.
 November 5, few (no collection made).

Collections in 1957 at Adult Station 25:

April 16, few S. venustum (one specimen).
 April 26, none.
 April 30, none.
 May 6, medium S. jenningsi.
 May 16, few unidentified.
 May 22, few S. jenningsi.
 May 27, few S. jenningsi.
 May 30, heavy S. jenningsi; few S. venustum; few S. decorum.
 June 10, few unidentified.

Adult Station 26 is the area where Cabin John Creek flows under MacArthur Blvd. There is some grassland in the vicinity but most of the area is wooded.

Collections in 1956 at Adult Station 26:

May 11, medium Simulium jenningsi.
 May 18, medium S. jenningsi.
 June 9, few S. jenningsi.

June 23, none.

July 21, none.

Adult Station 27 is at the intersection of Powder Mill Road and Little Paint Branch. This region is wooded with some grassland.

Collections in 1956 at Adult Station 27:

26 May--24 September, none (for list of dates of visits see Larval Station 27).

October 9, few Simulium jenningsi.

October 28, none.

Adult Station 28 is where Metzert Road crosses over Paint Branch. Large open fields border the site on one side and woods are on the other.

Collections in 1956 at Adult Station 28:

June 7, none.

Adult Station 29 is a park area in the region where the Northeast Branch flows under Calvert Road. Open areas of grass surrounded by woodland is the type of landscape found in this area.

Collections in 1956 at Adult Station 29:

June 9, few Simulium jenningsi (one specimen).

Adult Station 30 is located along the east bank of the Potomac River between C. & O. Canal Lock 8 and Stubblefield Falls. This area is very heavily wooded.

Collections in 1956 at Adult Station 30:

April 13, none.

June 23, none.

Adult Station 31 is a farm on the Patuxent River near Ashton. Observations were made along the river and around the farmhouse, as well as in woods and fields in the area.

Collections in 1956 at Adult Station 31:

July 4, none.

July 25, none.

Adult Station 32 is located north along the C. & O. Canal towpath from Lock 10 to the Stubblefield Falls area. This area is 1-1/2 miles long and is bordered on the right continuously by the Canal and on the left by woods, broken for about one-quarter mile in the center by a grassed picnic area. Collections were made at the grassed picnic area only.

Collections in 1956 at Adult Station 32:

June 23, medium Simulium jenningsi.

July 8, medium S. jenningsi.

August 11, heavy S. jenningsi. (Note: As soon as author entered grass area from woods, flies swarmed around his head.)

August 29, none.

Adult Station 33 is located in Silver Spring. This station is divided into two substations 33a and 33b. Substation 33a is located along the Sligo Creek Parkway, one-half mile south of U.S. 29. This area is a grassland recreation park with woods bordering the sides. Substation 33b is located at the home of Dr. C. A. Weigel in Woodside Park. Homes in this region have large lawns with many shade trees and shrubs.

Collections in 1956 at Adult Station 33:

May 22, Substation 33a, none.

June 21, Substation 33a, none.

June 26, Substation 33a, none.

September 12, Substation 33b, none.

September 17, Substation 33b, none.

October 15, Substation 33b, few Simulium jenningsi.

Collections in 1957 at Adult Station 33:

At Substation 33b Dr. C. A. Weigel made continuous observations during May and June. See Appendix F for his record.

May 9, Substation 33b, medium S. jenningsi.

June 13, Substation 33b, few S. jenningsi.

Adult Station 34 is a grass field surrounded by woods just north of where Brown's Lane crosses over Rock Creek. Large collections were made here standing in tall grass just inside the edge of the woods.

Collections in 1956 at Adult Station 34:

May 4, none (collection made one-half mile north of this area).

May 19, heavy Simulium jenningsi.

May 26, few S. jenningsi.

June 21, medium S. jenningsi.

June 26, heavy S. jenningsi; few S. vittatum (one specimen).

June 27, few unidentified.

July 15, few unidentified.

September 9, few S. jenningsi.

Adult Station 35 is the campus of the University of Maryland. While observations were made here throughout the summer by the author only the positive records are recorded

here. The region is made up of large areas of grassland with a few shade trees and shrubs around the buildings.

Collections in 1956 at Adult Station 35:

May 23, few Simulium jenningsi (one specimen).

June 27, few unidentified.

July 2, few unidentified.

October 2, few S. jenningsi.

Adult Station 36 is a private home on Exfair Road in Bethesda. Collections were made in the back yard which is surrounded by shrubs and shade trees.

Collections in 1956 at Adult Station 36:

June 21, medium Simulium jenningsi.

June 27, few S. jenningsi.

Adult Station 37 is a private home on Duvall Drive in Westmoreland Hills. Homes in this subdivision have extensive lawns and large amounts of shrubbery and shade trees.

Collections in 1956 at Adult Station 37:

May 4, none.

June 17, medium unidentified.

June 25, medium unidentified.

September 9, medium Simulium jenningsi.

Adult Station 38 is along the Potomac River one-half mile south of Herzog's Island. This region is wooded with some grass growing along the river's edge.

Collections in 1956 at Adult Station 38:

April 2, few Simulium vittatum (one specimen).

Adult Station 39 is the grass area around the north and west side of Greenbelt Lake.

Collections in 1956 at Adult Station 39:

May 13, none.

June 27, none.

Adult Station 40 is a wooded region where Paint Branch flows under Powder Mill Road.

Collections in 1956 at Adult Station 40:

May 12, none.

June 7, none.

Adult Station 41 is a grass area surrounded by woods on three sides and fields on the other. It is located at Falls Road and MacArthur Blvd.

Collections in 1956 at Adult Station 41:

May 18, heavy Simulium jenningsi; few S. vittatum (one specimen).

May 25, none.

July 21, few S. jenningsi.

Collections in 1957 at Adult Station 41:

May 6, few S. jenningsi.

Adult Station 42 is located at the University City Apartments near the intersection of Riggs Road and University Lane. The apartments are surrounded by woods and grass. The author's wife was outdoors usually for several hours each day during the 1956 and 1957 seasons, but she reported seeing adult flies only twice.

Collections in 1956 at Adult Station 42:

June 25, few unidentified.

August 9, few unidentified.

Adult Station 43 was at a miniature golf course north of the city limits on U.S. 1. The station was surrounded by fields with few trees.

Collections in 1956 at Adult Station 43:

July 2, none.

July 8, none.

July 15, none.

July 19, none.

July 30, none.

August 7, none.

Adult Station 44 is on the Potomac River (in a boat) between Chain Bridge and Francis Scott Key Bridge.

Collections in 1956 at Adult Station 44:

May 30, none (9:00 A.M.--3:00 P.M.).

Adult Station 47 is on the C. & O. Canal between Chain Bridge and Glen Echo, Maryland except at locks where portage was necessary.

Collections in 1956 at Adult Station 47:

May 29, medium Simulium jenningsi.

Adult Station 48 is the Woodmount Country Club.

Observations were made next to woods by a tee about one-quarter mile east of the ground-keeper's office.

Collections in 1957 at Adult Station 48:

May 27, medium Simulium jenningsi.

June 13, medium S. jenningsi; collection by R. S. Chandler.

June 17, medium S. jenningsi; collection by R. S. Chandler.

June 21, few S. jenningsi.

June 25, medium S. jenningsi; collection by R. S. Chandler.

DISCUSSION OF RESULTS

Ten species and two subspecies of black flies were collected during the survey made in 1956 and part of 1957. Three of the species were taken only once or twice; namely, Simulium fibrinflatum, S. parnassum, and Cnephia mutata. By referring to Appendix D, the date and collection station for these three species may be found. Stone and Jamnback (1955) have reviewed the biology of these three species, and since they appeared to be rare in the two Maryland counties surveyed, no further discussion is given here.

Before undertaking a review of the biology of Simulium jenningsi which is the primary pest species in this region, further discussion of the taxonomy of the two subspecific forms of this species is presented. Simulium jenningsi luggeri was described by Nicholson and Mickel (1950) as a new subspecies. No descriptions, however, of any of the larval stages are presented in Nicholson and Mickel's publication. They state that no dependable characters have been found to separate S. jenningsi luggeri from S. jenningsi jenningsi in the adult stage, but in the pupal stage the two forms may be separated in that S. jenningsi luggeri has 12 respiratory filaments present in contrast to the 10 found in the pupal stage of S. jenningsi jenningsi. Intergradation between the pupae of the two forms was not observed by Nicholson and Mickel, nor were the two forms collected together from the same stream.

The author collected pupae of both forms next to each other at the same collection station on the same date twice in 1956 and three times in 1957. All these collections were made from the Potomac River. The form which was called luggeri by Nicholson and Mickel (1950) is apparently a late spring form having but one generation a year in this region. Dates of collection of pupae may be found by referring to records of collections at Stations 17 (1957) and 21 (1956).

Although the concept of subspecies varies among taxonomists it is a recognized taxon. Mayr, et al. (1953) state that not more than one subspecies of any one polytypic species can exist in breeding condition in any one area. The author feels that these forms should be treated as separate species. Future work on the biology, taxonomy, and distribution of these two forms will clarify the question of treating them as distinct species or subspecies.

With the exception of four small collections made at Station 15 on the C. & O. Canal in 1956, larvae and pupae of Simulium jenningsi were collected only from the Potomac River. While regular collections were made at Station 17 in 1956 more intensive observations were made in the early part of the 1957 season to obtain more detailed information on the ecology of this species.

Larvae of Simulium jenningsi began to appear early in May in 1956 in the river on moss, stones, sticks, and grass blades trailing in the water. Pupae were present on May 11 and by May 25 most adults of the first brood had emerged. By

May 20 adult collections of S. jenningsi had been made at various collecting stations from Great Falls east to the University's Plant Research Farm at Fairland, Maryland.

On May 25 examination of the blades of the young waterwillow plants, Dianthera americana L., revealed hundreds of small larvae of the second brood had emerged. From this point on during the summer larvae were found at times in large numbers, but the only indication of the development of another brood in 1956 similar to the first and second was early in August.

Adult flies of this species were collected throughout the remainder of the season. Heavy flights were recorded as far from the river as Adult Station 11 (Fairland, Maryland) until late August but then began to taper off at the more distant locations from the river. At several stations nearer the Potomac, however, there was a marked increase in flight activity at the end of the season. Dr. C. A. Weigel of Silver Spring reported he was annoyed by these insects up until the middle of October in 1956.

In 1957 larvae appeared in the Potomac River at Great Falls in few numbers late in April. Pupae were present by April 30. Workers at Great Falls reported on May 6 that they had been troubled by adults since May 1. The waterwillow plants were three to four inches high on May 6 and larvae and pupae were collected from these. By May 16 the waterwillow was between six inches and a foot high. Very few pupae were found on this date indicating the first generation of flies had com-

pleted their development. On each plant, however, several hundred immature larvae of the second brood were found. A visit on May 22 revealed a few pupae and a heavy larval population. Between May 27 and May 30 the station was checked each day by the author. By referring to the 1957 collection records for this station on page 24 it can be seen that the population changed from larvae to pupae during this four day period. On June 10 and 11 a trace of larvae was found along with a few pupae indicating the second brood had completed its development.

It was noted in the 1956 and 1957 seasons that the level of the river showed a gradual decline during the spring and early summer from its winter peak. At the time the infestation of second generation larvae is at its height the young waterwillow plants are completely submerged flowing in the current just under the surface of the water. This perfect breeding situation undoubtedly accounts for the large size of the second brood. In the latter part of June of 1957, larval populations appeared at times to be building up, possibly indicating another generation, but no such event occurred.

Although Simulium jenningsi larvae were occasionally collected from rocks, sticks, moss, etc., the waterwillow plant seemed to be the preferred location for both larvae and pupae. Underhill (1944) reported that he collected larvae and pupae of this species attached to rocks, moss, and other objects but that they were most abundant on the waterwillow. He adds that in an ideal habitat the temperature of the water does not exceed 80° F. during the summer. The highest river temperature recorded

at Great Falls was 78° F. on June 16, but it is possible that it was higher at times during the season preventing the maximum development of the population.

The waterwillow plant was not found in any water course other than the Potomac. This might be an important reason why Simulium jenningsi was never found in any of the tributaries in the area surveyed.

In order to obtain additional data on the distribution of the adult flies a cooperative survey was planned for 1957. Forms were distributed to interested persons willing to assist, and specimens were requested to be collected by the observers.

Approximately 30 reports (but no specimens) were sent in from each of the subdivisions of Westmoreland Hills and Woodside Park (in Silver Spring). Other scattered reports were received from citizens most of which were from people living between Silver Spring and the Potomac. Dr. Floyd F. Smith, Entomologist with the U. S. Department of Agriculture, reported that while he had observed gnats flying in Bethesda and Silver Spring during May and June of 1957, he had not seen any flies or received reports from workers of any annoyance by these pests near Suell's Bridge, on the Patuxent River 2 miles east of Ashton. Another government entomologist, J. S. Yuill, reported he had not observed any black flies at Lanham, Maryland.

From the author's own observations and from information obtained from observers in the survey area, it appears that while being restricted to breeding only in the Potomac River Simulium jenningsi has a tremendous flight range and spreads

over many square miles of territory. Underhill (1944) reported collecting adults of this species 20 to 30 miles from the nearest known breeding places. He also reported this species as being present in large numbers 10 miles from the nearest known breeding spot. Heavy collections of S. jenningsi adults were made several times during the 1956 season at the University's Plant Research Farm at Fairland, Maryland, 11.5 miles from the Potomac River. The flies were generally most prevalent, however, in the area five to six miles east of the Potomac. The most distant collection made from the Potomac River of S. jenningsi was on October 9, 1956 at Adult Station 27. On that date two specimens were collected at this location which is in the Beltsville area, 13 miles from the Potomac River. Longevity and flight range studies similar to those conducted by Dalmat (1952) in Guatemala using dye markers are now in progress (July, 1957) in order to obtain additional ecological data on this species.

Underhill (1944) in his study of Simulium jenningsi reported that several meteorological factors may influence the activities of black flies, but that the effect of a change in atmospheric pressure was the most pronounced. Adults of S. jenningsi were collected by the author at various times from dawn to dusk. Most collections were made in grasslands near the edges of woods. Only a few adults of S. jenningsi were taken farther than 10 feet from the edge of a stream or grassland. Flies were collected several times during slight drizzles.

Stone and Jamback (1955) stated that larvae of Simulium

decorum are found almost invariably on dams, at lake outlets, or below large pools. A few larvae of this species were collected at Larval Collection Stations 2 (in the spring) and 1 (in the fall). Both of these stations are overflow outlets for large lakes. A few larvae, however, were collected at two stations, 3 and 13, which are permanent streams. Only at Station 15, the overflow by-pass around Lock 18 on the C. & O. Canal at Great Falls, were larvae and pupae of this species collected throughout the season. There were two peaks of abundance of the larval population here in 1956. The first and heaviest was in June, and the smaller occurred in October. The canal was dry, however, for a month in midsummer. Davies (1950) reported that there appeared to be two generations of S. decorum a year in Ontario. A build-up of the S. decorum population during June was again noted in 1957.

Adults of Simulium decorum were collected only at Great Falls during the two seasons. It should be mentioned that all adult collections of this species were made in the evening after 5:00 P.M. Their flight habits are considerably different from those of S. jenningsi. They are slow, heavy flyers which will land on any exposed area of the skin. They are difficult to capture since they are easily frightened.

Larvae of Simulium vittatum were found breeding in 17 of the 23 stations where larvae were collected in 1956. Stone and Jannback (1955) reviewed the life history and biology of this species, and the following information is for the most part supplementary to their review. Larvae of S. vittatum

were taken from March to November in 1956, throughout the entire period of field work. Two peaks of abundance of the larval forms were recorded, one in the spring and the other in the fall. There is probably a continuous production, however, of this species throughout the season.

Adults of this species were collected during this study one at a time and along with Simulium jenningsi. Nine out of the 10 specimens collected in 1956 were captured prior to July 1.

Simulium tuberosum larvae were collected from most of the permanent swift streams in the area surveyed. They were also collected from the Potomac River once in 1956. There are at least two and perhaps as many as four generations per year in this area. After the second generation it is impossible to distinguish one brood from another since continuous breeding occurs. While larval populations of this species occasionally become medium, they never equal the infestations one may find of S. vittatum, S. decorum, or S. jenningsi in this area. The nematode parasite mentioned earlier may be largely responsible for restricting the population of this species.

Although Simulium tuberosum has been reported to annoy man (Stone and Jamback 1955) only on one occasion during this study was there a possibility of a specimen of this species being captured in the adult form. This was when an adult specimen of the Simulium venustum complex (Stone and Jamback 1955) was collected at Station 11b on June 14, 1956, swarming with a flight of S. jenningsi.

Three of the species collected during the survey are early spring forms. Larvae of Prosimulium magnum were found in few numbers in three permanent rapidly flowing streams in April of 1956. The adults of this species were collected only once when a male and female were taken on April 28 along the C. & O. Canal at Great Falls by sweeping in grass.

A few larvae of Prosimulium hirtipes were collected in March and April of 1956 and 1957. According to Stone and Jamnback (1955) this species overwinters in the larval stage.

Ten adults of Prosimulium hirtipes were collected at several locations throughout the survey area by several observers in late April, 1956. (Collections were made at Great Falls, Adult Station 25; Patuxent Research Refuge, Adult Station 1; and the Plant Research Farm, Adult Station 11b and 11a.) None was recovered after April.

Simulium venustum has long been recorded as a pest species (Jamnback and Collins, 1955). Larvae of this species were found breeding in eight of the 22 stations where larvae were collected in 1956. The heaviest populations occurred late in April in 1956 and 1957. This species is the predominant one in the early spring in this region in small swift streams. No larvae of this species were found in either year after May 31. In the area studied there is probably but a single generation each year. In 1956 20 adults of this species were collected at four adult stations (Adult Station 1, Patuxent Research Refuge; Adult Station 25, Great Falls; Adult Station 11, Fairland; and Adult Station 7, near White Oak). Several were

collected at Adult Station 11, Fairland, in 1957. No adults were collected after June 10.

IMPORTANCE OF BLACK FLIES IN THE AREA SURVEYED

Herms (1953) states that there is no other insect of equal size that can inflict so painful a bite as the black fly. These insects are day biters and are usually found only outdoors. Some people seem to have a natural immunity to black fly bites, but in most persons the bite produces an allergic reaction which according to Matheson (1950) runs the following course:

...bite painless, followed by hemorrhagic spots of red patches; a papular lesion develops in 3 to 24 hours, and later a vesicular lesion which may last for a few days to several weeks. The lesions from several nearby bites may become confluent presenting a large vesicopapular lesion with considerable exudate followed by extensive edema, and the formation of oozing and crusted plaques. Pruritus (intense itching) begins shortly after the bites and may become diffuse with considerable heat and burning sensation; the pruritus may return periodically even after the lesions have apparently healed. Frequently the intense itching, followed by scratching, may cause secondary infection with more serious results. As the flies frequently attack back of the ears, over the eyes, cheeks, and neck, inflammation and edema at these sites may be marked. In addition...most people suffer from swelling of the lymphatic glands, which become tender and painful on pressure.

Although a few people in the area surveyed may have been bitten by black flies, the general complaint seems to be from the annoyance caused by the adults swarming around the head, flying into the eyes, and crawling in the ears and nose.

The swarms of flies annoying citizens in this region are made up almost entirely of Simulium jenningsi. However, during this survey not a single bonafide record was obtained of anyone actually being bitten by this species.

A small scale experiment has been undertaken by the Department of Entomology of the University of Maryland using DDT and BHC in fogs and mists, to determine the effectiveness of these insecticides for the control of adult black flies.

Actual bonafide records of persons being bitten by black flies during the period covered by this survey from March 1956 - June 1957 are as follows. The author was bitten by a female Simulium decorum on his hand June 5, 1956, and on his arm May 30, 1957. On April 28, 1956, a S. venustum female was collected biting the author's hand at Great Falls. Mr. Robert Evans collected two specimens of Simulium venustum which he reported had bitten him on May 26, 1956, at the Patuxent Wildlife Refuge.

Simulium vittatum has been recorded as biting man (Stone and Jamnback 1955) and, while no actual biting records of this pest were recorded during the survey, adults were taken swarming about the author's head on several occasions. It is possible that this species may be responsible for some of the biting complaints received in this region.

APPENDIX A
LIST OF COLLECTION STATIONS AND THEIR
COORDINATES ON MAP 1

Note: Letter A after station number indicates Adult Station only
Letter L after station number indicates Larvae Station only

<u>Station No.</u>	<u>Location</u>	<u>Coordinates</u>
1	Patuxent Research Refuge	Off map
2	Widewater C. & O. Canal.	Off map
3	Rock Run and MacArthur Blvd.	B-15
4	Potomac River Below Seneca	Off map
5	Patuxent Research Refuge	Off map
6	Brighton Dam, Ashton	Off map
7	Paint Branch Near White Oak.	T-6
8	Northwest Branch Near Glenmont	P-4
9	Northwest Branch Near Burnt Mills.	Q-9
10	Potomac River Near Widewater	Off map
11	Maryland Plant Research Farm	V-6
12L*	Potomac River at Great Falls	Off map
13	Rock Creek Near Rockville.	H-2
14	Rock Creek Near Forest Glen.	M-11
15L	C. & O. Canal at Great Falls	Off map
16	Northwest Branch at New Hampshire Avenue . .	T-12
17L	Potomac River at Great Falls	Off map
18	Cabin John Creek and River Road.	D-13
19	Little Falls Branch and Massachusetts Ave. .	I-17
20	Minnehaha Branch and Goldsboro Road.	G-16
21	Potomac River Near Glen Echo	F-16

APPENDIX A (Cont.)

<u>Station No.</u>	<u>Location</u>	<u>Coordinates</u>
24	University of Maryland	W-14
25	Great Falls.	Off map
26	Cabin John Creek at Glen Echo.	E-15
27	Little Paint Branch Near Beltsville.	X-6
28	Paint Branch and Metzert Road.	X-12
29	Northeast Branch Near College Park	X-15
30	Potomac River Near Cabin John.	D-15
31	Patuxent River Near Ashton	Off map
32	Potomac River at Stubblefield Falls.	A-16
33	Sligo Creek Near Silver Spring	P-12
34A	Rock Creek Near Bethesda	J-11
35A	University of Maryland	W-13
36A	Bethesda	I-15
37A	Westmoreland Hills	I-18
38	Potomac River Near Herzog's Island	Off map
39	Greenbelt Lake	AA-12
40	Paint Branch and Powder Mill Road.	V-9
41A	Falls Road and MacArthur Blvd.	Off map
42A	Lewisdale.	T-14
43A	Laurel	Off map
44	Potomac River Below Chain Bridge	I-21
45L	Anacostia River Near Riverdale	X-16
46L	Paint Branch Near Maryland University.	X-13
47A	Canal Between Chain Bridge and Glen Echo	G-18
48A	Woodmont Country Club, Rockville	F-5
49L	Rock Creek at Viers Mill Road	H-4

*All adult observations at Great Falls are listed under Station 25.

APPENDIX B

STATIONS AT WHICH ADULT FEMALES WERE COLLECTED DURING 1956
SPECIES

Adult Station No.	<u>Prosimulium</u> <u>hirtipes</u>	<u>P.</u> <u>magnum</u>	<u>Simulium</u> <u>jenningsi</u>	<u>S.</u> <u>decorum</u>	<u>S.</u> <u>vittatum</u>	<u>S.</u> <u>venustum</u>
1	X					X
2			X		X	
3			X		X	
6					X	
7			X			X
8			X			
11	X		X			X
15			X			
17			X			
18			X			
25	X	X	X	X	X	X
26			X			
27			X			
29			X			
32			X			
33			X			
34			X		X	
35			X			
36			X			
38					X	
41			X		X	
46			X			
47			X			

APPENDIX C

SPECIES OF ADULT FEMALES COLLECTED AT ALL STATIONS DURING 1956

Species Collected	Periods When Collections Were Made											
	April			May			June			July		
	1- 10	11- 20	21- 30	1- 10	11- 20	21- 31	1- 10	11- 20	21- 30	1- 10	11- 20	21- 31
<u>Prosimulium</u> <u>hirtipes</u>	1		9									
<u>P. magnum</u>			2									
<u>Simulium</u> <u>vittatum</u>	3		1		1		2		2			
<u>S. jenningsi</u>					340	83	47	174	324	57	1	80
<u>S. decorum</u>							1	3				
<u>S. venustum</u>			3	2	12	2	1	*1				

	August			September			October			November	
	1- 10	11- 20	21- 31	1- 10	11- 20	21- 30	1- 10	11- 20	21- 31	1- 10	
<u>P. hirtipes</u>											
<u>P. magnum</u>											
<u>S. vittatum</u>										1	
<u>S. jenningsi</u>	205	351	100	49	2	88	63	20	40	18	
<u>S. decorum</u>											
<u>S. venustum</u>											

* Possibly Simulium tuberosum

APPENDIX D

STATIONS AT WHICH DIFFERENT SPECIES OF LARVAE WERE COLLECTED
DURING 1956

Larval Station No.	<u>Prosimulium</u> <u>hirtipes</u>	<u>P. magnum</u>	<u>Cnephia</u> <u>mutata</u>	<u>Simulium</u> <u>vittatum</u>	<u>S. fibrin-</u> <u>flatum</u>	<u>S. jenningsi</u>	<u>S. decorum</u>	<u>S. parnassum</u>	<u>S. tuberosum</u>	<u>S. venustum</u>
1				X			X			
2				X			X			
3		X		X			X	X	X	X
6				X						
7	X	X							X	X
8		X		X					X	X
9									X	
11	X		X						X	X
13							X			
14				X					X	
15				X		X	X		X	X
16									X	
17				X		X			X	
18				X					X	X
21				X	X	X				X
25				X						X
26				X					X	
27				X					X	
28				X						
29				X						
30						X				
31				X						
32						X				
33				X						

APPENDIX E

SPECIES OF LARVAE COLLECTED, MARCH TO NOVEMBER DURING 1956

Species Collected	Periods When Collections Were Made												
	March			April			May			June			
	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-30	
<u>Prosimulium hirtipes</u>			3	2	2	2							
<u>P. magnum</u>				4	4	14							
<u>Cnephia mutata</u>					1								
<u>Simulium vittatum</u>		30		H*	F*	85	52	305	304	187	41	84	
<u>S. fibrinflatum</u>								1					
<u>S. jenningsi</u>							F*	56	21	H*	712	50	
<u>S. decorum</u>					5	2		14	3	30	585	1	
<u>S. parnassum</u>							5						
<u>S. tuberosum</u>					10	36	18	2	202	122	26	118	
<u>S. venustum</u>					45	118	39	36	2				
	July			August			September			October			Nov.
	1-10	11-20	21-31	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10
<u>P. hirtipes</u>													
<u>P. magnum</u>													
<u>C. mutata</u>													
<u>S. vittatum</u>	100			10	1	1	48	59	16	58	97	39	60
<u>S. fibrinflatum</u>													
<u>S. jenningsi</u>	F*	H*	H*	H*	F*	265	34	394	40	13	3		1
<u>S. decorum</u>								6		1	10	7	2
<u>S. parnassum</u>													
<u>S. tuberosum</u>	H*	70	47	37	57	34	124	136	74	63	13	26	2
<u>S. venustum</u>													

*F = Few larvae

*H = heavy larvae

APPENDIX F
REPORTS OF BLACK FLY ACTIVITY DURING MAY AND JUNE 1957 AT
SILVER SPRING

Observations below were made by Dr. C. A. Weigel at his home in Woodside Park, Silver Spring. Degree of infestation is not reported according to system used in the text of this thesis.

May 11	Very bad
12	Not as many as May 11
13	Plentiful and annoying
14	Few observed
15-24	Moderate numbers seen
25	Rather numerous
26	Very numerous
27-31	Status same, bad in morning
June 1-7	Very annoying and numerous
8	Very bad
9	Impossible to stay in yard
10-11	Same
12	Not so numerous
13	Bad before spray (Fogged using DDT)
14	Bad in morning
15	Few present
17-20	Few gnats
21-22	Heavy
23	Bad

APPENDIX F (Cont.)

June 24-25	Few gnats noted
26	Very annoying
27	Extremely numerous
28	Plentiful
29-30	Very numerous and annoying

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