Mass Movement of Black Fly Larvae on Silken Threads (Diptera: Simuliidae)[1]

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ABSTRACT

Stoppage of waterflow in a stream resulted in the migration of massive numbers of black fly larvae on silken threads. Larvae were found on single silken threads, but the heaviest concentrations were on "cables" composed of 25–50 individual silken threads. The larvae were attached in concentric rings around the silken threads and cables.

For 99 years it has been known that black fly larvae secrete silken threads when disturbed. In 1870, S. Green, a pisciculturist, wrote to C. V. Riley (Riley 1870a), describing his observations of the silken threads secreted by black fly larvae in trout breeding ponds. He did not know what these "worms" were, but he clearly described having numerous times seen a larva moving back and forth from one place to another secreting a very fine thread as it moved until a web of sorts was formed. He said "web" hardly described the mass of threads as they were not at all symmetrical but were generally an irregular mass of nearly parallel threads. Riley (1870b) identified the "worms" as simuliid larvae. Riley (1870b) and McBride (1870) noted that black fly larvae will secrete a delicate thread when disturbed. Jobbins-Pomeroy (1916) reported that black fly larvae can release threads from their silk glands immediately after they hatch. He noted that larvae when disturbed or caught in diminishing currents in streams let themselves be carried downstream steadied by silken threads. They then attached themselves to some stationary object from which they commenced seeking a more favorable site for reattachment. Puri (1925) reported similar movements of simuliid larvae on silken threads in streams. Wu (1930) reported observing larvae using the prolegs and mouth parts to move on single silken threads. When the larvae were on strands of several threads they moved either in the usual way or applied their posterior discs to the strands and proceeded with a looping movement of their bodies. Anderson (1960)[2] found that when black fly larvae were "suddenly disturbed or dislodged from their points of attachment, the larvae are swiftly carried along by the current, but usually still remain attached to their substrata by strands of sticky 'silk' secreted by their salivary glands." Anderson further noted that when a branch or rock was removed from a stream, larvae could be seen swinging freely in the air while remaining attached to the object by an almost invisible thread. Rubtsov (1962) reported that change of day and night, mechanical shock, increase of turbidity, and change of current velocity could cause the falling of simuliid larvae from their places of attachment. Often as they fell they secreted a silken thread from their original point of attachment so that they could climb back up if they wished to. He pointed out that this thread might be more than 1 m long and was very strong. He also reported that larvae might move longer distances without the use of threads if the current was strong enough to carry them along after they fell free from their places of attachment. Rubtsov (1964) wrote that in 30 years of observing black flies he had never seen any larvae floating suspended (on threads). If the larva was completely cut off from the object to which it was attached, it would alternately float free for a few meters and then attach itself again by its lifeline (thread).

While rearing various species of Simuliidae in the laboratory, we have noted on numerous occasions silken thread formations in our aquariums after larval hatches. When new cultures of black fly eggs were set up, the 1st appearance of the threads in the aquariums was a good clue that the larvae had hatched from the eggs. The number of threads present in any 1 aquarium was dependent upon the number of larvae that hatched from the eggs. The more larvae present the greater the number of silken threads. Once the larvae attached to the sides of the aquarium or to the air lines leading to the air stones, the threads were no longer used. However, if the larvae were subsequently disturbed, they again released silken threads which they used to reestablish themselves in another area in the aquarium or at their original attachment site after the disturbance ceased.

We also have noted the formation of silken threads by larvae when they were taken from natural breeding sites at the Seney National Wildlife Refuge, Seney, Mich., and introduced into aquariums. On several occasions when we introduced massive numbers of larvae (15,000+) into our aquariums, the larvae emitted so many threads that the larvae became entangled within the mass of threads and died. In 1 case the entangled larvae died 48 hr after their introduction into the aquarium (Fig. 1). After observing this phenomenon a few times we were careful to add no more than several thousand larvae to any aquarium at 1 time. In the field we have often demonstrated the black fly larvae's use of silken threads. When we scraped larvae from objects in running water, they could immediately be observed drifting out into the water on silken threads.

On May 27, at the T-Pool runoff stream, Seney Refuge, we observed a striking and most unusual display of larval migration on silken threads. While

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[2] J. R. Anderson. 1960. The biology and taxonomy of Wisconsin black flies (Diptera: Simuliidae). Ph.D. thesis, University of Wisconsin, Madison. 150 p.

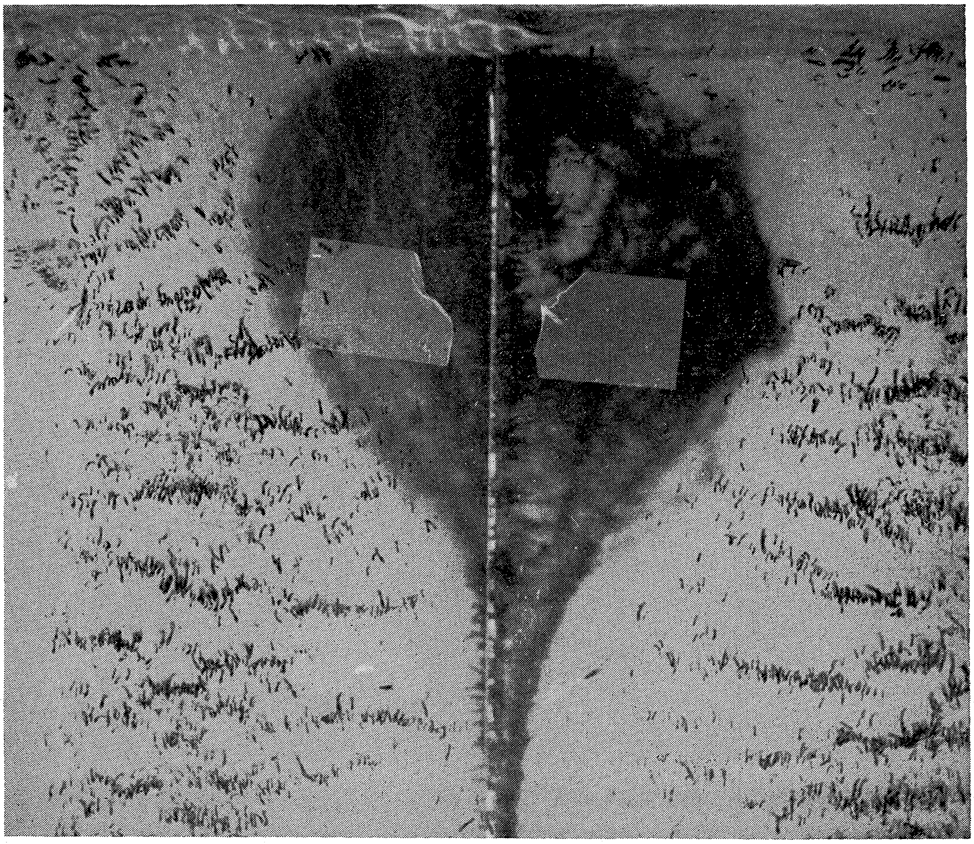

FIG. 1.—Simuliid larvae in aquarium. The center "funnel" is a silken thread mass with larvae entangled within it. (The 2 rectangular light areas near the top of the "funnel" are plastic tapes on the inside of the aquarium.)

studying large populations of larvae of *Cnephia dacotensis* (Dyar & Shannon), *Simulium decorum* Walker, *S. venustum* Say, and *S. verecudum* Stone & Jamnback on rocks and boulders in a runoff stream below a spillway, the spillway boards were inadvertently replaced in the spillway abutments causing an almost complete cessation of waterflow from the pond over the spillway, into the runoff stream. At the base of the spillway, before the flow was interrupted, for a distance of ca. 25 ft the runoff stream was ca. 30 ft wide and 6–18 in. deep with a current flow of 2.49–4.93 ft/sec. Beyond the first 25 ft of the runoff stream, the stream narrowed a little and its flow was 3.71 ft/sec when the spillway was open. After the boards were put in, the first 25 ft of the stream dwindled to a 12-in.-wide, ¾-in.-deep stream with a current flow of 0.27–0.92 ft/sec. The water forming this small stream came from between some loose spillway boards. The remaining portion of the runoff stream also was reduced in width and depth, but not quite so immediately or drastically. Forty ft from where the larvae were found on the rocks below the spillway the stream flow was 0.49 ft/sec; at 54 ft, 0.92 ft/sec; at 62 ft, 0.38 ft/sec; at 105 ft, 0.92 ft/sec; at 166 ft, 0.71 ft/sec; at 193 ft, 0.27 ft/sec; and at 240 ft, 0.60 ft/sec.

Prior to the slowing down of the water at the spillway, the rocks and boulders at its base harbored hundreds of thousands of larvae in various stages of development. Afterwards the same rocks were found to be almost totally devoid of larvae. At first observation it was believed that the larvae had died because of the absence of water and had dropped off the rocks and boulders into the silt below.

Forty-eight hr after the reduction in flow of the water, the junior author noted fine threads of a silvery-white silky material in the runoff stream 50–240 ft downstream from the rocks and boulders at the base of the spillway. On closer examination we observed massive numbers of larvae on the silky material, and the greatest numbers of these threads and larvae were in the stream where the water was still flowing at the current velocities listed above. There were many larvae on single threads, but the heaviest concentrations were on "cables" composed of 25–50 individual silken threads. Single silken threads and "cables" ranged in length from 3 to at least 25 ft and many were possibly longer. The larvae were attached in concentric rings around the silken cables at intervals of ½ to 1 in. Several hundred larvae of each of the aforementioned species were found in each ring (Fig. 2). On microscopic examination (with high dry and oil immersion objectives) the silken threads and cables were found

FIG. 2.—Simuliid larvae attached in concentric rings (see arrows) around "cables" in a runoff stream following a great decrease in waterflow. Dark wavy bands to right of arrows are clusters of thousands of larvae. (About ⅛ actual size.)

FIG. 3.—Silken web formations of simuliid larvae draped over surface of water, a sand bar (A), aquatic plants, and tree branch (B). Dark wavy bands are clusters of thousands of larvae entangled in webbing (see arrows). (About ⅛ actual size.)

FIG. 4.—A silken "cable," with simuliid larvae attached, being transferred to a container for transfer to the laboratory. Stringy masses in foreground to left of transfer container are larvae attached to silken threads and "cables" in runoff stream.

to be identical to the silken threads produced by larvae in our rearing aquariums. The threads and cables were smooth, unbroken, unbranched and did not have any cellular structures such as are seen in some aquatic plants.

In addition to the single silken threads and cables, we found fine, silken webs on the surface of the water in which were intermingled thousands of larvae. These webs lay over sand bars and in sand depressions in midstream as well as draped over various aquatic plants and detached tree limbs (Fig. 3). The webbing also was silvery-white. Microscopic examination showed that this material consisted of many threads and cables inter-twined and interwoven at random.

We fairly easily removed many of the silken cables with larvae attached (Fig. 4), placed them into plastic-lined, water-filled containers and transported them to the field laboratory for introduction into rearing aquariums. This procedure proved to be a very easy way of obtaining massive numbers of larvae from a stream. Within a few hours after introduction, the larvae had established themselves on the bottoms and sides of the aquariums as well as on the air stones and air lines.

Most of the silken threads and cables were gone from the runoff stream 2 days after they were first observed on Apr. 27. As the water level continued to drop in the runoff stream we found thousands of dead larvae in masses of silken material draped over tree limbs, aquatic vegetation and sand in the middle and along the banks of the stream.

Though simuliid migrations on silken threads have been reported in the literature by various investigators and observed by the senior author over a period of 6 years, we have never seen or read of such a spectacular display of larval migration as we observed at the Seney Refuge in the spring of 1967. Threads of such great length, the formation of threads into cables (except for Wu's (1930) oblique reference), the attachment of larvae in concentric rings and the formation of webbing so large as to drape over objects as it did in this instance were all new phenomena to us.

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BOOK REVIEW

THE FLIES OF WESTERN NORTH AMERICA, by Frank R. Cole, with the collaboration of Evert I. Schlinger. 1970 (Jan. 20, official release date, although the title page says 1969). University of California Press, Berkeley and Los Angeles. xi + 693 p., frontispiece (color), 360 text figs. $25.00.

The appearance of Cole's book on western Diptera, a labor of love by the author for four decades, has long been eagerly anticipated. At last we have it, a comprehensive treatment of one of the major orders of insects for "Western North America," here meaning north of Mexico and west of the eastern boundaries of Saskatchewan, Montana, Wyoming, Colorado, and New Mexico, plus Alaska on the north and Baja California on the south.