BLACK FLIES – BIOLOGY AND CONTROL

Edward John Bechinski and Marc J. Klowden
Division of Entomology, University of Idaho
Moscow, ID 83844-2339

INTRODUCTION

Black flies, also commonly known as buffalo gnats (or even more simply as gnats), are aggressive blood-feeders on people, domestic livestock and a variety of warm-blooded wildlife. About 40 different species of black flies are known from Idaho. Each has its unique pattern of seasonal biting activity and specialized environmental requirements. Many of Idaho's black flies only occur in remote mountainous regions where they seldom are encountered as pests. Indeed, most of our black flies might best be considered beneficial for the roles they play in the diets of native fish and birds.

There is one species of black fly in Idaho that is a particularly notorious livestock pest: *Simulium vittatum*, sometimes unofficially called the striped black fly. This insect has been reported since the 1930's in Idaho as a severe pest of sheep, cattle and horses. Surveys conducted during black fly outbreaks in the 1970's showed that *Simulium vittatum* comprised more than 99% of all the black flies associated with grazing sheep in south-central Idaho. In addition to its numerical abundance, this pest also is geographically widespread – it occurs across the agricultural areas of southern Idaho where it breeds in streams and rivers as well as in irrigation canals. *Simulium vittatum* seems to be the predominant species in the regional outbreaks that began during 2001 in both the Treasure Valley and Magic Valley areas and that have continued during 2004.

This publication describes the biology of *Simulium vittatum* and practical steps you can take to control this insect. Most of what we know about the seasonal biology of *Simulium vittatum* in Idaho comes from research conducted during the 1970's in the Twin Falls area.[1] Exact details of pest biology in other parts of the state may differ from those described here, but general patterns of occurrence and habitat preferences likely are similar across southern Idaho and adjoining eastern Oregon.

IDENTIFICATION and BIOLOGY

Like all flies and many other insects, all species of black flies develop through four distinct life stages: egg ➜ larva ➜ pupa ➜ adult. The immature stages – egg, larva and pupa – are entirely aquatic. Black flies do not breed in manure or organic garbage as do house flies and some other flies that bother livestock. Furthermore, immature black flies only can develop in moving, running water. This absolute requirement for flowing water contrasts with the habitat requirements of another blood-feeding fly, the mosquito, which instead only can develop in still, standing water.

Eggs of *Simulium vittatum* appear as brown gelatinous thread-sized strings on plants, sticks and rocks submerged in the water. Several females often lay eggs on the same substrate, resulting in mats of eggs several inches long (**Figure 1**). The dark-bodied, worm-like larvae (**Figure 2**) hatch from eggs and drift downstream on the current. Larvae produce silken threads which they spin into a pad on submerged objects; the tip of their body bears a single leg with a circle of tiny hooks that allows the larva to firmly attach itself to the silk pad and remain stationary for feeding.

---

[1]James Ingvard Jessen. 1977. *Black Flies (Diptera:Simuliidae) Which Affect Sheep in Southern Idaho.* Ph.D. dissertation. University of Idaho

Figure 1. *Black fly egg masses with other immature life stages on aquatic plants.*

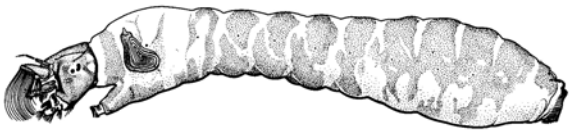

Figure 2. *Black fly larva showing filter-feeding fans on head and bulbous posterior body segments; mature body size is 2/10-inches.*

Larvae feed by means of two small comb-like fans that filter algae, bacteria and fine particles of leaf debris or other organic matter suspended in the water. Larvae normally remain attached to submerged objects but can drift downstream several inches on silken threads if their habitat is disturbed. Long distance drift sometimes results in dramatic week-to-week changes in larval populations. Larvae molt (shed their skins) 7 to 11 times, each time growing to a larger body size. Full-grown larvae are approximately 2/10th-inches long.

Mature larvae molt into a pupa (**Figure 3**), a non-feeding, non-mobile transitional stage during which the insect develops the body features of the adult fly. The pupa itself is enclosed within a slipper-shaped brownish silken cocoon that remains attached to the substrate under the water. Pupae breathe by means of a pair of distinctively shaped tubular, branched gills that project forward from the head. Both the larval and pupal stages of *Simulium vittatum* often anchor themselves to submerged aquatic plants or on bank-side grasses and weeds that trail their leaves into the water. Pondweed (*Potamageton pectinatus*) in irrigation canals sometimes is completely covered with black fly larvae and pupae **(Figure 4)**.

Figure 3. *Black fly pupa within slipper-shaped silk cocoon; tubular, finger-like gills project forward from head.*

Figure 4. *Black fly larvae and pupae sometimes nearly cover aquatic plants.*

PHOTO CREDIT: Marni Porath and Kimberly Wallin, Oregon State University

After several days to a few weeks, depending on water temperature, the pupa molts to the adult stage. The fly rises through the water inside an air bubble that breaks the surface and allows the adult to escape to a resting site on vegetation at the margins of the water where their wings expand to full size and their bodies harden. Once they reach the adult stage, black flies do not grow to a larger body size.

Simulium vittatum adults are about 1/16-inch long, generally dark grey-to-black, with a distinctive hump-backed appearance when viewed in profile (**Figure 5**). In spite of their common name, certain other species of Idaho black flies (especially in the genus *Prosimulium*) are orange-to-tan colored rather than black. The hump-backed thorax of *Simulium vittatum* is marked on the top with 3 thin dark stripes, but this feature is not unique to this species. Definitive identification to species only can be made by expert technical examination.

Under magnification, a pair of short, pointed antennae can be seen projecting forward from the head of adult black flies. The mouthparts of female are prolonged into a stout, downward-pointing, knife-like blade that pierces the skin of their host animal (**Figure 6**). Male black flies have two large prominent eyes that meet together at the front of the face, while females have smaller eyes that are separated at the front of the face.

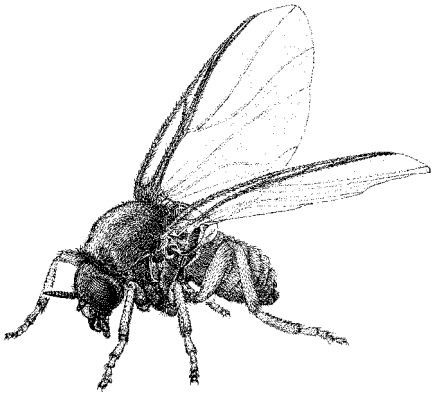

Figure 5. *Adult black fly showing characteristic stout-bodied, hump-backed appearance.*

Figure 6*. Black flies feed by piercing the host's skin with knife-like mouthparts; in this specimen the abdomen is swollen with ingested blood.*

SEASONAL LIFE CYCLE

Partially mature larvae are the sole overwintering stage of *Simulium vittatum* in Idaho. Larvae primarily survive the winter in natural flowing waters ranging in size from small upland streams to wide rivers, including the Snake River. Larvae also can survive in irrigation canals that have permanent water flows during the winter months. This insect does not overwinter as any life stage in canals that run dry after the cropping season, nor can it survive the winter in still, pooled water that remains in canals.

Larvae cannot survive freezing but can develop in water that flows under ice during the winter. They slowly develop through the winter and spring months to the pupal stage and emerge as adult flies during early-to-mid April. Some female flies continue local breeding cycles in streams and rivers; others disperse during late April and early May to nearby irrigation canals. Female flies crawl down plants and lay up to 600 eggs. This initial spring period of egg laying occurs without any blood-feeding by the female fly; egg-laying during later generations typically only can occur after the female fly ingests a blood meal.

Larvae and pupae of this first summer generation are present in rivers and canals through late May to early June, with new adults emerging from canals during mid June and beginning another egg-laying cycle. Adults live about 1-month.

Egg-to-adult development requires 3-to-4 weeks under typical summer conditions. The exact time required for development mainly depends on water temperature. Development is slowest (longest) when water temperature is cold and is fastest when water temperature is warm; development is twice as fast during the summer when canal water temperature is 75 ˚F compared to late spring water temperatures of 60 ˚F. In other parts of North America, *Simulium vittatum* develops in waters as cold as 38 ˚F to waters warmer than 80˚F.

At least three generations of *Simulium vittatum* annually develop in southern Idaho and as many as seven generations are possible. There is so much variation among individuals in their developmental rates that larvae and pupae occur in canals as overlapping, continuous generations from May until water flow ends in October. Population size typically increases as summer progresses and reaches seasonal peaks during late summer. By mid-summer, adult flies emerge daily from canals and persist as pests in the fall until a killing frost.

PEST STATUS
– factors that favor outbreaks
Whereas many other species of Idaho black flies are restricted as larvae to cool, clear mountain streams, *Simulium vittatum* tolerates a relatively wide range of water conditions that allow it survive in a variety of natural and human-made flowing water habitats. In south-central Idaho around Twin Falls, local irrigation canals seem to be the primary breeding source of black flies that attack livestock during the summer months. In contrast, black fly problems in southwestern Idaho seem to originate from the Snake river and its tributaries.

Environmental factors that can make irrigation canals especially well-suited for *Simulium vittatum* include

- constant (dependable) water flow throughout the irrigation season
- warm summer water temperatures (70 to 75 ˚F) that allow for rapid larval development
- abundant pondweed and other submerged plants where larvae and pupae attach
- enriched food supply in the form of algae and suspended organic particles

Together these factors allow for sustained, continuous build-up of black fly populations from late spring through early fall. Studies in the Twin Falls area showed that larval and pupal populations tended to be highest in the upstream reaches of canal systems nearest the lake or reservoir outlet rather than in downstream points more distantly located from the outlet, presumably because plankton and other larval foods are most abundant at outlets.

Silty, sediment-laden irrigation canals are unfavorable larval habitats. Ironically, the Best Management Practices (BMPs) adopted by farmers in recent years to minimize soil erosion and reduce sediment loads in irrigation return waters may have unintentionally enhanced black fly survival and population size by improving water quality. Swift-flowing, cool mountain streams above 6500-ft elevation with many rocks and little aquatic vegetation seem to be relatively unfavorable summer larval habitats for *Simulium vittatum* in Idaho.

– biting behavior

Adult female black flies are the only ones that feed on blood and so are the only pestiferous stage. Both males and females of *Simulium vittatum* feed on the nectar of flowers, including alfalfa and small-flowered weedy plants. Males only feed on nectar and therefore are never pests.

Females only feed on the blood of mammals (i.e., warm-blooded vertebrates). They locate potential hosts by flying upwind toward increasing concentrations of carbon dioxide that animals produce on their breath and from their skin. Differences among individuals in amounts of carbon dioxide produced explain why black flies (as well as mosquitoes and other blood-feeding flies and gnats) are attracted to some people more than others.

At closer ranges, black flies also depend on vision to locate potential hosts. Mating swarms of gnats often congregate over visual markers (such as a tree or rock), including animal and human hosts which they sometimes follow for hundreds of feet. Females tend to be attracted to dark-colored (blue and black) silhouettes. Yellow-green objects are attractive to egg-laying female flies. This color preference can be used to monitor egg-laying activity by floating lengths of yellow-colored rope in canals and streams as artificial egg-laying sites (**Figure 7**).

Figure 7. *Black fly egg laying can be monitored by floating lengths of yellow-colored rope in flowing waters where larvae breed. Image on right shows rope glistening with black fly eggs and larvae 1-week after placement in an irrigation canal.*

Like many other species of black flies, *Simulium vittatum* has definite daily biting activity periods. Under sunny summer skies, gnats are most active in the morning and again during the evening; biting activity generally is highest between 7 to 10 a.m. and again at 4 to 7 p.m. Under cloudy, cooler conditions, biting may occur throughout the day with peaks during early afternoon. Air temperature below 50 ˚F especially reduces fly activity. Breezy, windy conditions also reduce biting activity; relatively few flies are active when wind speed exceeds 5 mph. Adult black flies rest during non-biting periods on bank-side vegetation and wet rocks next to streams, rivers and canals. Adults also can be found on residential and farm buildings and on backyard lawns and landscape plants.

The black fly biting season in Idaho essentially spans the crop irrigation season. But black fly problems are not restricted to areas next to canals or other larval habitats. Studies in south-central Idaho suggest that adult *Simulium vittatum* readily fly 10-to-15 miles from these larval breeding habitats; prevailing winds and passing weather fronts transport adult black flies even longer distances from larval habitats.

– host range and injury

Simulium vittatum only rarely bites humans, but when it does, the bite can be quite painful. Individual reaction to bites results from the body's allergic response to the saliva that the female injects as she feeds. Her saliva contains anti-clotting agents that allow the fly to feed more easily. The bite itself appears as a raised pinkish welt with a red-purple spot in the center. Many people experience itching that lasts for several days after a bite, but severe allergic reactions such as asthma also have been reported. Bites of some Idaho black flies sometime result in a syndrome called "black fly fever" with symptoms that include headache, fever, nausea and large swellings around the neck. Unlike mosquitoes, none of our North American black flies transmit disease-causing pathogens to humans. In the tropics of Central and South America and Africa, other species of black flies transmit parasites that cause river blindness in humans.

Even though *Simulium vittatum* is almost exclusively a biting pest of livestock and not people, it still can be an intolerable nuisance to anyone working or playing outdoors. Black flies have the maddening habit of flying around the face and crawling through the scalp or into eyes and ears and under open shirt collars. Swarming, crawling gnats around the head can be as irritating as the bite itself.

Simulium vittatum mainly feeds on the blood of sheep, cattle, horses and mules, especially where body hair is sparse and skin is thin such as around the eyes and nose, inside the ears, and along the belly. Repeated feeding on the ears of horses can result in secondary infections and scabby, swollen granulations that sometimes require surgical removal (**Figure 8**). Poultry (chickens, ducks and geese, turkeys) and hogs are less frequent hosts of *Simulium vittatum*.

Figure 8. *Simulium vittatum especially feeds inside the ears of horses; here the ear has been folded back to show the scabby tissues typical of black fly feeding.*

Figure 9. *Sheep respond to black fly attack by by bunching together low on the ground and refusing to graze.*

Extreme black fly attack can kill livestock either from toxic shock reactions to the fly's saliva or accidents when animals try to escape fly attack. Calves can be physically suffocated if massive numbers of gnats crawl into the respiratory system. Overall, animal deaths are rare. Economic losses to ranchers and dairy operators instead usually occur as reductions in animal weight or milk production caused when fly attack makes it difficult for animals to feed.

Livestock attempt to escape attack by bunching up together and refusing to graze. Bands of sheep often stand in tight groups with their heads down, exposing only their backs and refusing to graze; individual animals lay prone with their heads and ears flat on the ground (**Figure 9**). Cattle and horses similarly

bunch together, constantly flicking their ears and kicking up dust. Animals sometimes stay under trees and bushes rather than grazing in the open where fly attack is most severe. The concentrated trampling of pasture and rangeland vegetation can be severe.

The stress of black fly attack also can increase an animal's susceptibility to pneumonia or other stress-related respiratory diseases. *Simulium vittatum* apparently can transmit the virus that causes vesicular stomatitis in livestock, though its exact importance in virus transmission is not known.

BLACK FLY CONTROL

Adult black flies readily disperse several miles from their larval breeding habitats and so continuously invade pastures, feedlots and other livestock areas as well as residential backyards distantly located from breeding sources. This means that long-term relief from ultimately depends on reducing larval populations where they breed – in streams, rivers, irrigation canals and other running waters. But in the short term, there are some practical steps you can take against adult black flies.

– protecting yourself from adult black flies

You can reduce but not eliminate personal harassment from swarming black flies when working outside around the farm or home by adopting a three-step CAR approach: Confuse, Avoid and Repel.

Confuse black flies by wearing light-colored clothing –
Dark colors are more attractive to adult black flies than light colors; especially avoid dark blue clothing because it is particularly attractive.

Avoid outdoor activities when black flies are most active –
Simulium vittatum is most active for a few hours after sunrise and again during the early evening a few hours before sunset. If you must be outside during these times, consider wearing hats that cover the ears (or fine-veiled head nets) and tight-fitting long-sleeved shirts without buttons so as to minimize numbers of gnats that otherwise might crawl into the ears and under shirt collars or through button-holes. Black flies do not bite through clothing, so cover exposed skin as much as practical.

Repel black flies by using insect repellents that contain DEET –
The synthetic chemical N,N-diethyl-3-methylbenzamide (formerly N,N-diethyl-m-toluamide), more simply called DEET, can protect you and your family from black fly attack as well as from ticks, fleas, mosquitoes and other biting flies. Products are sold in Idaho under more than 100 different brand names (such as *Cutter, Off!, Sawyer* and *Ultrathon*), but regardless of brand name, each product always lists on the label the active ingredient as DEET or N,N-diethyl-3-methylbenzamide or N,N-diethyl-m-toluamide.

Although DEET is called a repellent, it actually seems to interfere with the insect's ability to recognize us as potential hosts. Commercially available sprays and lotions range from 5% to 100% DEET. The more concentrated products do not provide higher levels of protection but instead simply last longer on the skin or clothes than less concentrated products. In general, 30 to 50% DEET is adequate for adults.

Guidelines established by the American Academy of Pediatrics recommend a conservative approach to using DEET repellents on children. ***Do not use products containing more than 10% DEET on children***. Adults always should apply DEET to children, avoiding the eyes, mouth and nose as well as skin covered by clothing. ***DEET products are NOT RECOMMENDED for infants less than 2 years old.***

Never use DEET products on pets, horses or on livestock animals because they will ingest the chemical when they groom themselves.

Natural alternatives to DEET are available and include plant oils (cedarwood, citronella, eucalyptus) and IR3535 (technically known as 3-[N-butyl-N-acetyl]-aminopropionic acid, ethyl ester), a chemical related to an essential naturally occurring amino acid. Table 1 lists the names of products available in Idaho. Tests with mosquitoes have shown that the plant oil products provide lesser protection than DEET; it is safe to assume that they are similarly less effective than DEET against black flies.

TABLE 1. Alternatives to DEET for black fly repellents in Idaho

trade name	% active ingredient	manufacturer	signal words
products that contain IR3535			
SKIN-SO-SOFT Bug Guard PLUS IR3535 Insect Repellent Moisturizing Sunblock Lotion SPF 30	7.5%	Avon Products	caution
SKIN-SO-SOFT Bug Guard PLUS IR3535 Expedition Insect Repellent Aerosol	20.1%	Avon Products	warning
SKIN-SO-SOFT Bug Guard PLUS IR3535 Insect Repellent Moisturizing Lotion	7.5%	Avon Products	caution
SKIN-SO-SOFT Bug Guard PLUS IR3535 Insect Repellent Spray	7.5%	Avon Products	caution
Bug Guard Plus IR3535 Active Insect Repellent Gentle Breeze Towelettes	7.5%	Avon Products	warning
products that contain cedarwood oil and oil of citronella			
BUG BLOCK SUNSCREEN AND INSECT REPELLENT	0.5% and 4.2%	W F Young Inc	caution
products that contain oil of eucalyptus			
REPEL LEMON EUCALYPTUS INSECT REPELLENT LOTION	30%	WPC Brands	warning
REPEL LEMON EUCALYPTUS INSECT REPELLENT SPRAY LOTION	30%	WPC Brands	warning
SURVIVOR LEMON EUCALYPTUS INSECT REPELLENT	30%	WPC Brands	warning
REPEL PLANT BASED LEMON EUCALYPTUS INSECT REPELLENT	40%	WPC Brands	caution
products that contain p-Menthane-3,8-diol			
OFF! BOTANICALS TOWELETTES	8%	SC Johnson & Son	caution
OFF! BOTANICALS INSECT REPELLENT	10%	SC Johnson & Son	caution

TABLE NOTES:

(1) Signal words designate the relative risk a pesticide will cause harmful health effects on humans, where *caution* = slightly toxic, *warning* = moderately toxic, and *danger* = most toxic. The U.S. Environmental Protection Agency (EPA) considers all products listed here to pose little acute risks to human health except for possible eye irritation.
(2) Avon product line includes additional IR3535 repellents not listed here that differ with respect to fragrance and/or sunscreen content.
(3) p-Menthane-3,8-diol naturally occurs in the leaves and twigs of the lemon eucalyptus plant but is chemically synthesized for commercial use.

Electronic devices that claim to repel insect by emitting ultrasonic sounds or electromagnetic signals have no value for alleviating black fly nuisance. More than 25-years of scientific research has shown that these devices do not repel any insect. Potentially more useful are the backyard mosquito traps (eg., *Mosquito Magnet* and many other brands) that emit plumes of carbon dioxide and other attractants. These devices really do lure and kill mosquitoes and so likely attract and trap black flies too, but it remains to be seen if these devices trap enough insects to reduce pests to tolerable levels.

Insecticides can be applied as aerosol fogs or as light mists in backyard areas to kill black flies as they rest on plants and buildings. However, except for the most extreme black fly infestations, we recommend against such applications. At best, backyard premise sprays only provide temporary relief that lasts no more than a few days. Flies that arrive after insecticides evaporate will not be killed. Further, the

available insecticides are not specific in their killing action to black flies. Products instead also kill lady beetles and other natural enemies that help keep plant-feeding pests in check. These insecticides also are lethal to honeybees and other pollinators necessary to set fruits and vegetables.

If you do decide to spray backyard vegetation, be sure the label says the insecticide can be applied to your specific plants and that it additionally says it kills adult black flies or adult mosquitoes. If you are making applications around vegetable gardens, fruit trees and other plants that bear edible produce, it is especially critical to make sure that your crops specifically are listed on the insecticide label. If not, you have the wrong product and could inadvertently poison yourself or your family.

– protecting livestock from adult flies

insecticides

Numerous commercially available insecticides can be used in Idaho for application either directly to livestock animals or as premise sprays in or around livestock buildings to kill adult black flies. Lists of approved products for beef and dairy cattle, horses, sheep, goats and hogs are posted at website of the *University of Idaho Pest Management Center*,

http://agweb.ag.uidaho.edu/ipm/

Insecticides by themselves only can provide livestock with short-term biting relief from adult black flies. All of the available products have relatively short residual killing action – they only last for several days – and so must be applied repeatedly during the biting season at time intervals as permitted by the pesticide label.

alternatives to insecticides

Although black flies are highly mobile, biting intensity usually is greatest next to irrigation canals and streams or rivers where the larval stages of this pest live. Pasture your animals as far away from these pest sources as practical.

Unlike mosquitoes, black flies generally do not enter buildings or other enclosed, darkened spaces. Simply-constructed shelters consisting of three solid walls and a roof can provide cattle, horses and sheep with refuge from biting attack in pastures and rangelands. Black fly control for beef and dairy cattle can be enhanced by placing insecticide-charged back rubbers at the entrance to shelters. When practical, keep your animals inside barns during the morning and early evening hours when biting tends to be heaviest.

Black flies especially buzz around the heads of horses and feed near the ears. Petroleum jelly smeared around the ears and head creates a physical barrier that black flies cannot penetrate. Commercially available “fly-mask” mesh nets that fit over the head and ears of the horse similarly exclude black flies.

Finally, as noted previously, it is illegal to use DEET products on pets, horses or livestock animals. Grooming animals will ingest the chemical and may become sickened.

– area-wide approaches to larval management

Successful larval control requires coordinated region-wide pest management action across the broadest possible geographic range of larval habitat and so is beyond the capability of an individual landowner to accomplish alone. No single method of larval control by itself can provide satisfactory reductions in fly attack. Area-wide management instead depends on bringing together several different control methods into an overall pest management program.

natural enemies

Numerous fish and birds (such as trout and ducks) feed on the adult and larval stages of black flies, but little if anything can be done to practically manipulate populations of these natural predators in ways that enhance their impact. In areas where they are abundant, black flies can be critical part of the diet of fish and birds. Hence, pest control programs for black flies can have unintended harmful impacts on ecosystems.

A more promising natural enemy is a tiny parasitic nematode, *Gastromermis viridis* [Mermithidae], known from prior surveys in the irrigation canals of south-central Idaho. This roundworm penetrates the body wall of larval black flies where it feeds internally, eventually growing so large that it entirely fills the internal body cavity of the black fly (**Figure 10**). The parasite kills the black fly when the juvenile worm exits from the larva. In other regions of the US, worms can persist into the pupal and adult stages of the black fly before killing their host.

Figure 10. *Black fly larval cadaver (dark, thicker body form at top of photo) following emergence of parasitic nematode (thin, long coiled worm at bottom of photo).*

In the Twin Falls area where they were studied, nematode-infected black fly larvae usually were first detected in canals during the initial June generation. Parasitism increased through the season and reached larval kill rates of nearly 100% at some sites during August and September. The highest attack rates were at the downstream parts of canals most distantly located from reservoir outlets. In spite of these extreme larval kill rates, adult fly populations never declined below levels pestiferous to sheep. Much more research will be required before we can directly use nematodes to control black flies. This worm is not available commercially for mass-release into canals.

habitat management

Because black flies require running waters for egg-to-pupal development, immature black flies can be killed by manipulating water flows. For example, water levels in irrigation canals could be raised and lowered at regular intervals during the summer so as to strand black fly eggs, larvae and pupae on vegetation above the water line. Alternatively, water could be impounded into still, non-flowing pools between canal gates; several consecutive days of interrupted flow would be required because larvae of *Simulium vittatum* can survive (but not complete development) a few days in still, stagnant water. Even more extreme, water flow into canals temporarily could be stopped and the system allowed to run completely dry, thereby totally eradicating the immature pest population.

Pragmatic need for dependable flows of irrigation water throughout the cropping season makes any of these manipulations difficult if not outright impossible. Even if it was possible to alter water flows, the effect on black fly larvae and pupae would be dramatic but temporary. Adult flies that had previously emerged would recolonize the canal by laying more eggs when flow returned to normal; further, these pre-existing adult flies still would be present over the short term as pests.

Another approach to habitat manipulation that is compatible with efficient delivery of irrigation water is weed control – to eliminate the aquatic plants where larvae and pupae anchor themselves – by either treating irrigation canals with chemical herbicides or by mechanical removing submerged and floating plants. Studies in the Twin Falls canal system during the 1970's suggested that the herbicide acrolein (sold under the trade name *Magnacide H*) not only kills aquatic weeds but also is directly toxic to *Simulium vittatum* by interfering with larval muscle control. Larvae disappeared from canals treated with acrolein the day following herbicide application; pupae were not affected by herbicide treatment and completed development to adult flies. Early-season weed control particularly might provide relief by reducing numbers of fly generations later during the year.

larval insecticides

The only insecticides that legally may be applied to waters in Idaho for black fly control are those that contain the active ingredient *Bacillus thuringiensis israelensis*, or Bti for short. Bti is a bacterium that produces a toxin that only is lethal to the larval stages of black flies, mosquitoes, fungus gnats and related flies. Bti essentially is harmless to fish, birds, and people; the only organisms it kills are the larval stages of a few related types of flies.

Bti insecticides do not contain living bacterial cells but instead consist of the toxic crystalline protein naturally produced by *Bacillus thuringiensis israelensis*. The formulated insecticide is applied directly to the water (**Figure 11**) where the filter-feeding black fly larvae ingest the suspended toxic crystals. The toxin must be eaten by the larvae to be effective; it has no killing action by external contact with black fly eggs, larvae, pupae or adults. Application timing is critical because Bti is most effective against the smallest (youngest) larvae. Larvae sometimes die within 30-minutes of ingesting a lethal dose or they may linger a day or two.

Figure 11. *Commercial application of Bacillus thuringiensis israelensis insecticide into an irrigation canal for larval black fly control.*

Bti products do not produce self-generating infections because no living bacterium is present to recycle itself in the environment. As soon as the toxic crystals dissipate on water currents, potential larval killing action immediately ends. Any new larvae hatching from eggs will not be killed. A single Bti application has no immediate impact on pre-existing gnat nuisance problems because Bti only kills the larval stages. Regionally coordinated, repeated Bti applications are required to reduce pest populations because adult black flies continually repopulate the habitat with more eggs.

Bti products registered with the Idaho State Department of Agriculture for use by commercial pesticide applicators to control black fly larvae are sold under the trade names *AQUABAC* and *VectoBac*. Product labels permit ground and aerial application to virtually any natural or artificial water site except finished drinking water reservoirs or drinking water receptacles. Bti also is sold under still yet different trade names (*Bayer Advanced Garden Mosquito Preventer RTU Granules, Bonide Mosquito Beater Plunks WSP, Healthy Ponds Mosquito Control*, and *Summit Mosquito Bits, Mosquito Dunks* and *B.T.I. Briquets*) in consumer-sized packages for backyard mosquito control by homeowners. It would not be cost-effective for individuals to independently treat localized black fly larval habitats on their own property because adult flies would continue to emerge and invade from adjacent untreated breeding sites.

SUMMARY

Several factors contribute to the importance of *Simuliun vittatum* as a pest of livestock and people in the irrigated agricultural regions of southern Idaho and eastern Oregon:

- larvae can survive in a variety of natural and human-made habitats
- multiple generations per year allow for pest increase from April through October
- adult flies disperse several miles from larval habitats.

Together these factors make it practically impossible to reduce black fly problems by solely focusing on killing adult flies. But there is a weak link in the biology of this pest that we can exploit to more effectively reduce black fly populations: immature stages only can develop in running waters. Long-term solutions to black fly problems ultimately require a regionally coordinated program that eliminates the pest in its breeding sites before it can develop to the biting adult stage.

ACKNOWLEDGMENTS

Figures 1, 6-9 and 11 courtesy of R.L. Stoltz, Extension Professor Emeritus, University of Idaho; Figure 10 courtesy of J.I. Jessen, formerly University of Idaho.

ABOUT THE AUTHORS

Edward John Bechinski is an Extension Pest Management Specialist and Professor of Entomology, edb@uidaho.edu

Marc J. Klowden is a Research Entomologist and Professor of Entomology mklowden@uidaho.edu

5 January 2005