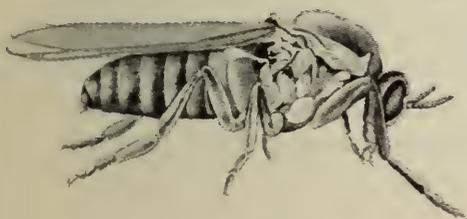


Control of
Black Flies
in Canada

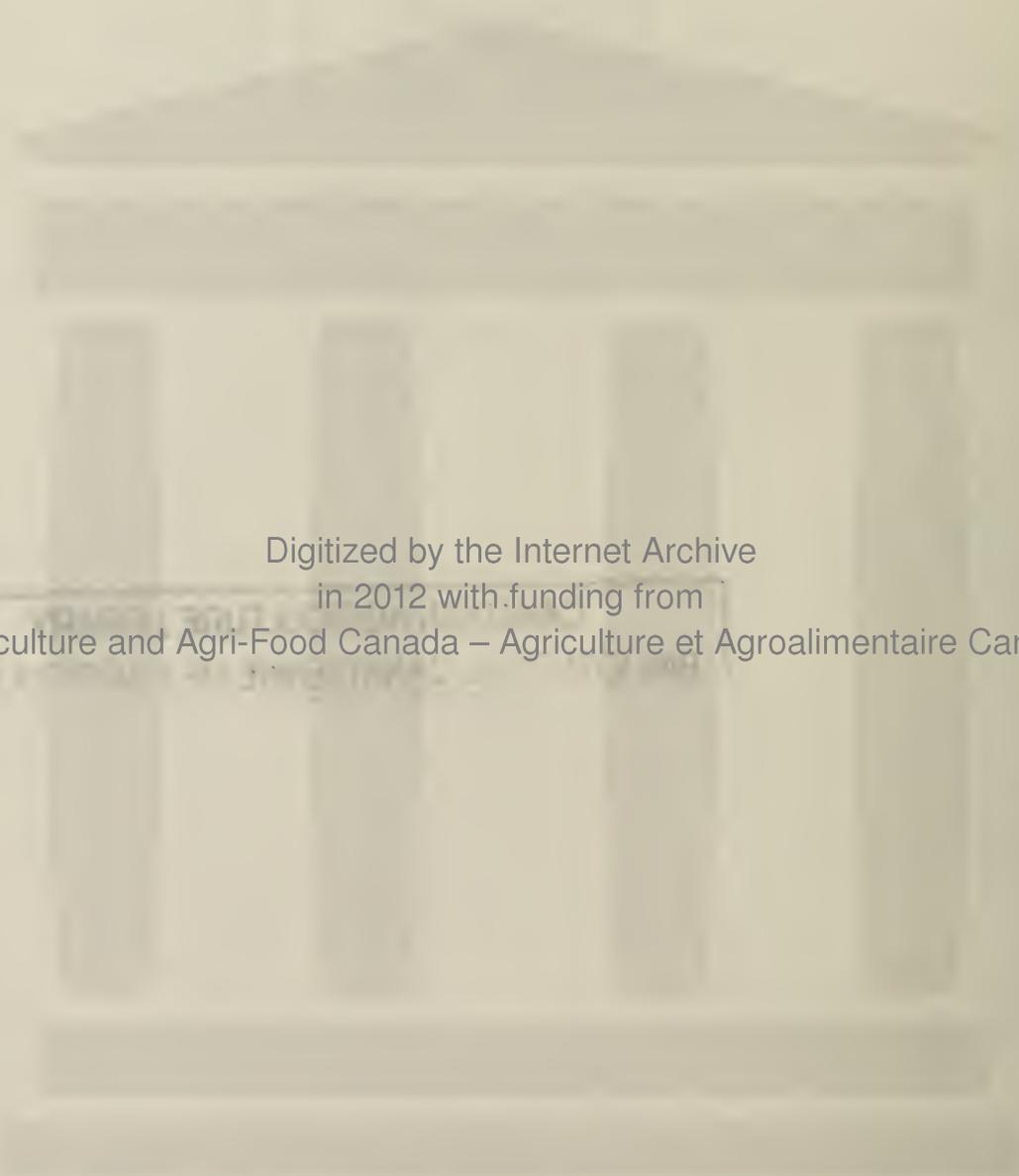
by C. R. TWINN and D. G. PETERSON

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CONTROL OF BLACK FLIES IN CANADA

by

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INTRODUCTION

Black flies, sometimes also called buffalo gnats, are small, stout-bodied, humpbacked flies with short, broad wings and short legs. Most species are black or dark-colored, but some are gray. There are at least 60 species of these flies in Canada. Both sexes feed on the nectar of flowers, but the females of most species also feed on the blood of wild and domestic animals, including birds, and several species¹ attack man. The males do not bite.

Unlike mosquitoes, black flies bite only during the day. On animals they crawl through the hair or feathers to the skin or enter the ears and nostrils. Many deaths of livestock caused by black flies have been reported in parts of southeastern Europe, in parts of the southwestern United States, and in Saskatchewan. On humans, in addition to biting exposed parts of the person, they crawl through openings in the clothing and bite various parts of the body. Frequently, their bites are not felt when first inflicted, but later the poison introduced with the bites often causes swellings and hard lesions that may remain sore and itchy for days. In biting, some species of black flies transmit disease. They have not been implicated in carrying human diseases in Canada, but in some parts of Africa, Mexico, and Central America they transmit a filarial disease of man known as onchocerciasis. In North America, including Canada, certain species are the carriers of important protozoon blood parasites of ducks, turkeys, and other birds.

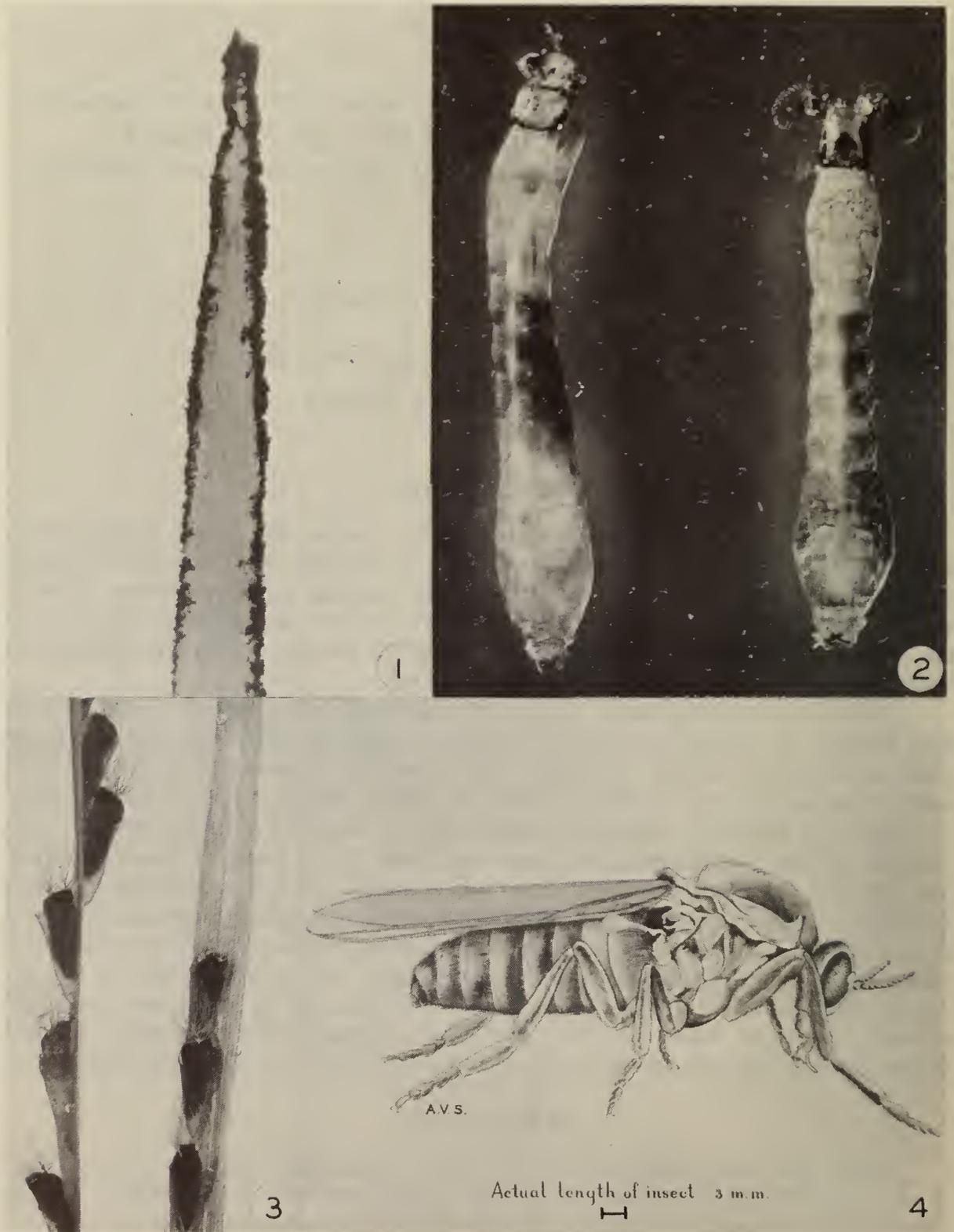
LIFE-HISTORY

Black flies pass through four life-stages: egg, larva, pupa, and adult (Figures 1 to 4). The first three stages develop only in running water (Figures 5 to 8): in the rapids of rivers, in streams, in rills, and in drainage ditches; one species² breeds only in, or just below, waterfalls. The different species vary considerably in life-histories and habits. A number of species, including a widespread and abundant pest species³, lay their small, glistening yellow eggs in compact masses on vegetation, stones, and other partly submerged objects at or near the

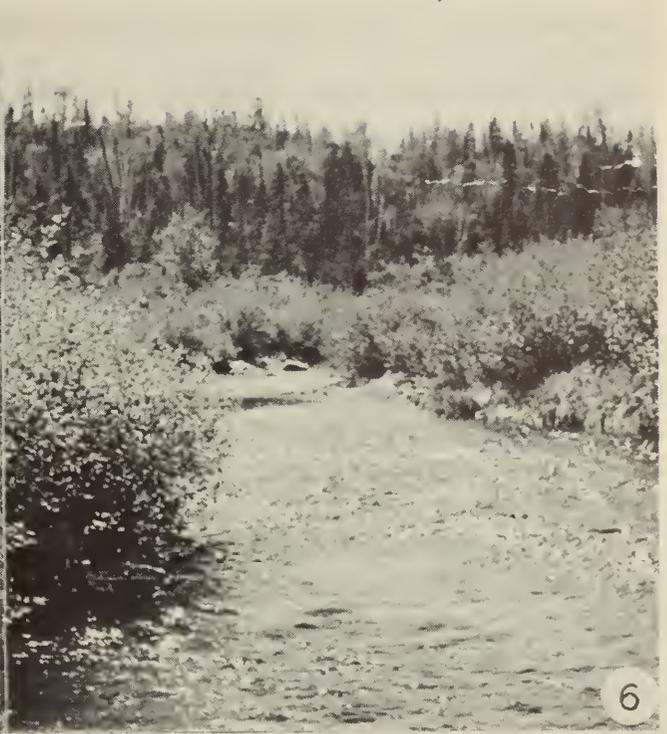
¹ Notably *Simulium venustum* Say and *Prosimulium hirtipes* (Fries).

² *Simulium pictipes* Hagen.

³ *Simulium venustum* Say.



Life-stages of a black fly: 1, eggs on a leaf; 2, mature larvae; 3, cocoons and pupae on leaves; 4, adult.



Some types of streams suitable for black-fly development: 5, slow-moving stream; 6, shallow and swift stream over gravel bed; 7, shallow rapids with numerous rocks; 8, deep, swift rapids.

surface of the water where they are immersed or continually wetted. Sometimes the flies even enter the water to deposit their eggs. Other species, including an important pest of livestock in Saskatchewan⁴, lay their eggs while flying over the surface of the water; the eggs sink to the bottom and may remain there for many months before hatching. Black-fly larvae spin fine threads on objects in the water and anchor themselves to these by tiny circlets of hooks at the tail end of the body and on a proleg behind the head. These prevent them from being washed by the current and enable them to move from place to place in the water with a looping motion.

The larvae, which when full-grown are about three-eighths of an inch long, feed on organic particles strained from the water and swept into the gullet by a pair of fanlike mouth brushes. They breathe by obtaining oxygen from the well-aerated water through three small gills at the tail end and through the skin of the body. They may be dark brown, green, or pale in color. They attach to stones, vegetation, submerged logs, and other objects in the water, and when very numerous may appear as slimy, moss-like coatings.

The larva molts (sheds its skin) six times as it grows, and changes to a pupa with the final molt. Before pupating, the larva spins a cocoon, which is firmly attached to various objects in the water. The cocoon varies in shape and character in different species; for example, in some⁵ it may consist of loosely woven silk of indefinite shape and in others⁶ it is closely woven and slipper-shaped. The larva transforms to a pupa and is firmly anchored within the cocoon. The pupa breathes through two tufts of respiratory filaments that project from the front end of the body. The number and arrangement of these filaments vary in different species. The duration of the aquatic life-stages also varies; it may be two or three weeks or many months, depending on species, temperature, and other conditions.

Transformation of the insect into the winged adult takes place within the pupal skin. On emerging, the flies take flight immediately on reaching the surface of the water. They may live from a few days to several weeks. Some species have only one generation⁷ each year, whereas others have two or more⁸, depending on latitude; the generations overlap, so that during the summer all stages may be found together. The winter is passed in the egg stage by some species⁹ and in the larval stage by others¹⁰.

The black-fly season is longer than that of most other biting flies. In southern Canada black flies often make their first appearance on the wing in late April, reach their greatest abundance in June and July, and persist in diminishing numbers well into October. Their season is progressively shorter the farther north one goes; for instance, at Churchill, on Hudson Bay, it extends only from the end of June to September.

There is little precise information on the distances that black flies may travel. Prairie species are known to disperse several to many miles from their breeding places; one species (probably wind-borne) was reported attacking livestock as far as 100 miles from its source. Forest species are less likely to move

⁴ *Simulium arcticum* Mall.

⁵ e.g., *Prosimulium hirtipes* (Fries).

⁶ e.g., *Simulium venustum* Say.

⁷ e.g., *P. hirtipes* Fries, *S. arcticum* Mall.

⁸ e.g., *S. venustum* Say, *Eusimulium aureum* (Fries).

⁹ e.g., *S. arcticum* Mall.

¹⁰ e.g., *S. vittatum* Zett.

long distances because of their more sedentary habits and the confining effect of the forest cover.

CONTROL

DDT is toxic to black-fly larvae and adults and provides an effective and economical means of control. As the primary measure in a control program, it may be used to destroy the larvae in infested streams in or near the area to be protected. As a supplementary measure, it may be used to control the adults. In difficult terrain, where applying larvicides may be impractical, it may be necessary to place greater reliance on measures against the adults.

Control of Larvae

A control program against the larvae needs careful planning and execution. Requirements include large-scale maps, a knowledge of the ground, and adequate assistance. The objective is to destroy the larvae infesting all streams within a radius of at least five miles from the center of the area to be protected. The greater the radius of the protected area, the less the probability of re-infestation from beyond its limits.

Make a survey of all streams in the area as soon as possible after they are free of ice in the spring, to determine the extent of infestation and the stage of black-fly development. The best time to apply the larvicide is when most of the larvae are maturing (about three-eighths of an inch long), and before pupation commences.

Apply a DDT larvicide to the streams at points as far upstream as it is practical to reach, and, if possible, treat small streams at or near their sources. The application is best made at the heads of rapids or similar places where turbulence accelerates the mixing of the insecticide with the water. When there is no turbulence, use a branch or stick for mixing.

Apply the larvicide as a 5 or 10 per cent solution of DDT in fuel oil at the rate of one part of the active ingredient to ten million parts of water (1:10,000,000) for 15 minutes at the point of application. This dosage is sufficient to eliminate black-fly larvae for several miles downstream. When properly applied, it is not harmful to fish and does not seriously affect other aquatic life. DDT emulsion may be used instead of the oil solution, but in this form the DDT is more toxic to fish and other aquatic forms.

Determine the quantity of DDT solution required to treat a stream in the following manner. At a convenient point measure the width and the average depth of the stream, in feet. Then measure the velocity of the stream in feet per second at the same point with a hydrographic flow meter, or by timing a floating object over a measured distance of not less than 10 feet. The floating object should be heavy enough not to be affected by the wind. When the latter method is followed, the average velocity is about two-thirds of the measured velocity. From these measurements calculate the volume of water that passes a given point during a 15-minute period, and from this the amount of 5 to 10 per cent solution of DDT in fuel oil needed to give the required dosage. These calculations may be simplified by use of the following formulae:-

$$(a) \text{ Number of pints of a 5 per cent DDT solution} = \frac{V \times W \times D}{9} \text{ and}$$

$$(b) \text{ Number of pints of a 10 per cent DDT solution} = \frac{V \times W \times D}{18} \text{ and}$$

where V = average velocity in feet per second, W = width in feet, and D = average depth in feet¹¹.

Pour the measured amount of DDT solution into the stream at an even rate over a period of 15 minutes. Examine the stream 24 hours after treatment to determine its effectiveness.

Inspect treated streams at intervals of two or three weeks throughout the summer to detect any reinfestation that may occur, and repeat the treatment if and when large numbers of larvae are found to be present.

A DDT solution may also be sprayed from an aircraft for the control of black-fly larvae (see "Aircraft Spraying").

Control of Adults

Where effective action has not been taken against the larvae, or where the area has become infested from surrounding untreated areas, use space sprays to obtain local temporary relief (a space spray in a fine spray, mist, or aerosol consisting of very small droplets of insecticide solution that are dispersed by movements of the air). The droplets come in contact with the adult insects that are in flight or at rest. Daily treatments may be required when black flies are abundant in the region surrounding the treated area. Space sprays do not produce an effective residual deposit of insecticide.

Aerosols are the most effective space sprays against black flies. Aerosol generators (Figure 9) are available commercially in several designs and in sizes ranging from those with a capacity of one gallon and an output of two gallons per hour to those with a capacity of 45 gallons or more and an output of 45 gallons per hour.

Use aerosol generators in the evening or early morning hours, or during overcast days, when meteorological conditions are usually suitable and the wind rolls the aerosol close to the ground. They are less effective on warm sunny days as convection currents may disperse the aerosol into the upper air. Wind speeds of two to four miles per hour are most suitable for the dispersion of aerosols over open ground. In forest areas, wind velocities up to 10 miles per hour are satisfactory.

Move the generator along parallel lines across the area to be treated, at right angles to the direction of the wind, and in shingle fashion. This ensures that the entire area is covered by the aerosol. The effective distribution of an aerosol downwind from the emission line depends on atmospheric conditions, e.g., wind velocity and direction, as well as on the delivery rate of the machine, density of vegetation, and other factors. Allow approximately 200 feet between the parallel emission lines to ensure a sufficient concentration of the aerosol.

¹¹The formula $\frac{V \times W \times D}{9}$ is derived as follows:

The number of pounds of water that flow past a given point in 15 minutes = $V \times W \times D \times 60 \times 15 \times 62.5$.
The number of pounds of DDT required for a dosage of 1:10,000,000 for 15 minutes =

$\frac{V \times W \times D \times 60 \times 15 \times 62.5}{10,000,000}$. Since approximately 1 pound of DDT is contained in 20 pints of a 5 per

cent solution of DDT in oil, the number of pints of a 5 per cent DDT solution required is

$$\frac{V \times W \times D \times 60 \times 15 \times 62.5}{10,000,000} \times 20, \text{ or } \frac{V \times W \times D}{9}$$



Aerosol generator

Use a five per cent solution of DDT in No. 2 fuel oil, diesel oil, or special fogging oil and apply it at the rate of 0.1 to 0.2 pound of DDT, or approximately one to two quarts of solution per acre. Applying one-half to one gallon of solution to each 100 yards of emission line gives the correct dosage. Where there is a fire hazard in the forest, water emulsions may be substituted for oil solutions.

Aircraft may be used to spray large areas with DDT in oil solution to control infestations of black-fly adults.

Aircraft Spraying

Spraying from aircraft is effective and economical for the treatment of extensive areas to control both larvae and adults. A DDT solution is dispersed from the aircraft as an atomized spray. For applications against larvae this should consist of small droplets sufficiently numerous to ensure that, under suitable meteorological conditions, the streams below receive a sufficient dosage to control larvae; against adults a more finely atomized spray is required so that all adult insects in the area are hit by enough insecticide to kill them.

Including aerial spraying in a black-fly control program requires consideration of a number of factors, such as the nature of the terrain, location of airfields, cost, and available funds and manpower. Aerial spraying need not be employed exclusively, but may be integrated into a program that includes the use of ground equipment. The following are advantages in using aircraft:-

1. Extensive breeding areas that may be inaccessible by other means are within easy reach by air.

2. Scattered and widespread breeding areas can often be treated as effectively and more rapidly than with ground equipment.

3. Sudden and widespread infestations of adult black flies can be rapidly controlled.

4. Commercial operators may be hired, avoiding a large investment in equipment.

The following are disadvantages of aerial spraying:-

1. Spraying is restricted to overcast days and the hours between sunset and sunrise, when meteorological conditions are usually such that the spray can be properly distributed.

2. The distribution of the spray and the dosage applied from aircraft are more difficult to control than with ground equipment.

3. Limited areas can be treated more economically by ground equipment.

A variety of aircraft are employed for aerial spraying, including biplanes, e.g., the Cub type; twin-engined monoplanes, e.g., the Dakota DC-3; helicopters; and autogyros. The light planes are operated at low cost, manoeuvre well, and do not require long runways. The twin-engined aircraft have longer range and greater load capacity. Helicopters are expensive, but do not require runways and the rotors help to force the spray down.

A variety of equipment is available for installation on aircraft for aerial spraying. This includes boom-and-nozzle assemblies, straight emission pipes, and a rotary-brush assembly, all of which may be operated with gravity flow or a pump to give an even output. Efficient equipment should release the insecticide at a uniform and adjustable rate and spread the spray in wide and even swaths.

Select the aircraft to hire after considering the following points:-

1. Extent of the area to be treated.

2. The nature of the terrain over which the aircraft must operate.

3. The distance from an airfield and the load that the aircraft can carry. A low capacity increases the cost of a large-scale operation.

4. The spraying equipment with which the aircraft is fitted.

Plan and organize the aerial spraying program with care. The operator should follow the instructions prepared for him, and the success of the application depends upon how well the operation is planned. Remember the following important points:-

1. Familiarize the pilot with the area to be sprayed. This should avoid costly delay and wasted material.

2. Proper timing of applications is of great importance in both larval and adult control.

3. Ascertain the success of the operation by pre- and post-spray assessments of the numbers of black flies in the treated areas.

4. Prepare adequate mixing and loading facilities for the insecticide solution, unless these operations are the responsibility of the commercial operator.

For the control of black-fly larvae by aircraft, use a 10 per cent solution of DDT in No. 2 fuel oil or diesel oil. Apply it directly to the infested stream, either by flying the length of the stream, emitting the spray at intervals, or by laying down repeated swaths across the stream, near its source. In extensive areas containing numerous infested streams, larval control may be achieved by an area spray. Apply the spray in parallel swaths, approximately a quarter of a mile apart, to cover the entire area with a dosage of approximately 0.2 pound of DDT per acre. The aircraft should be flown at a height of approximately 100 feet. Mark on a

large-scale map the area to be sprayed and the spray runs that the pilot should fly in order to obtain an even deposit of larvicide. A pattern of parallel spray runs, the pilot flying back and forth across the area, is the normal spray plan. The spray runs should be approximately at right angles to the direction of the wind so that it will spread the spray in a wide swath. The swath width, i.e., the distance between the parallel spray runs, depends on the height of the aircraft, the speed and direction of the wind, and the type of spray equipment. As a rule, the aircraft should be flown at approximately 100 feet to obtain the maximum effective swath width. Select a road, railway line, lake shore, river, or other obvious topographical feature that may be used as a base line for the spray runs. If possible, place a visible marker at the start of each spray run to act as a guide for the pilot.

For the control of adult black flies by air-craft, apply a 5 or 10 per cent solution of DDT in No. 2 fuel oil or diesel oil over the infested area at the rate of approximately 0.25 pound of DDT per acre.

Study the legal aspects of aerial spraying in the community. There are provincial and federal regulations that may apply to these operations. Insurance is necessary for protection from possible loss of life, or injury, or damage to property.

PERSONAL PROTECTION

Where other measures have not been taken or are inadequate, personal protection for those engaged in outdoor work or recreation may be obtained by wearing suitable clothing and using repellents.

Clothing

Considerable protection is afforded by clothing that prevents black flies from entering the spaces between the garments and the person. Keep shirt sleeves closely fastened. Tuck the trousers inside the socks or long boots. Zippers on the flies of trousers and shirts help to keep black flies out. The color of clothing is important: light colors are less attractive to black flies than dark ones. Clothing may be made more protective by treating it with repellents.

Head-nets made of fine-mesh bobbinet or other suitable material and long enough to extend over the shoulders protect the head and neck.

Repellents

Repellents, when properly applied to exposed skin, should give protection for about two hours under most conditions. If the black flies are very plentiful and are biting intensely, the best of the repellents may require renewal at least as often as once an hour. Outstanding among the repellents are dimethyl phthalate, dimethyl carbate, ethyl hexanediol (Rutgers 612), and Indalone. These chemicals and mixtures of them have been incorporated into numerous proprietary preparations now being widely sold in Canada, both in liquid and in ointment form. Typical formulae include dimethyl phthalate alone, and a 6:2:2 mixture of dimethyl phthalate, Rutgers 612 or dimethyl carbate, and Indalone. Twelve drops of repellent should be sufficient for the face, neck, and both hands. Apply it evenly on exposed skin surfaces. Avoid getting it in the eyes or on the lips as it may cause a temporary stinging sensation.

On clothing these repellents retain their effectiveness for much longer periods than on the skin. Applying them by hand or by sprayer to the outside of the clothing, particularly around the collar, waist, and cuffs, and on the flies of shirt and trousers, has definite protective value.

For further information write to the Veterinary and Medical Entomology Unit, Science Service Building, Ottawa.

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