ARTICLES

STUDIES ON PORTABLE JET AEROSOL GENERATORS FOR CONTROL OF ADULT MOSQUITOES [1]

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This study is an extension of tests already reported (Brown and Watson, 1953) for 5 machines used in mosquito control, whose emission rates range from 20 to 40 g.p.h. In this instance the generators tested are portable, and their emission rates range from 2 to 9 g.p.h. Determinations were made as before of the droplet spectra, of the amounts of the insecticide reaching various distances downwind, and of the effectiveness against adult *Aedes* mosquitoes in woodland at dosages similar to those employed with the larger machines.

MATERIALS. The following 2 machines were tested:

1. The Swingfog Pest Control Unit (Fig. 1), which is a portable aerosol generator that weighs 24 lb. empty and approximately 34 lb. filled. The aerosol is generated by a pulse-jet heater, operating at 80 pulsations per second, according to the Schwingfeuer system developed by Heizmotoren, G.m.b.H., Uberlingen, Bodensee, Germany. The type SN Swingfog machine built by that company is marketed by Devenco Inc., 150 Broadway, New York 38, N. Y., and is distributed in Canada by McDonald Bros. Equipment, Box 1019, Billings Bridge, Ottawa, Ontario. The fuel is gasoline, supplied from a tank holding 1 imp. qt. (1.2 U. S. qt.), sufficient for 1 hour's operation. The insecticide is contained in a tank holding 3.5 imp. qt. (4.2 U. S. qt.), and is pushed to an outlet nozzle under 6 p.s.i. air pressure tapped from the jet unit. Atomized from this nozzle, it enters a fog-mixing tube covering the outlet of the exhaust pipe. According to the manufacturer, the exhaust temperature is 400–450° C., and the temperature of the oil fog at the outlet is approximately 130° C.

2. The Dyna-Fog Jr. Jet Insecticidal Fog Generator (Fig. 2), a portable aerosol generator that weighs 15 lb. empty and 33 lb. filled. The aerosol is generated with the aid of a spring-steel flutter-valve, the pulse-jet operating at 83 pulsations per second. The machine is marketed by Curtis Automotive Devices Inc., Bedford, Indiana. The gasoline fuel is supplied from a tank holding 1.6 imp. qt. (1.9 U. S. qt.), sufficient for 55 minutes' operation. The insecticide is contained in a tank holding 1.5 imp. gal. (1.8 U. S. gal.), and is pushed by air pressure to the outlet nozzle in a fog-mixing tube. Ignition is provided by flashlight batteries incorporated in the Dyna-Fog Jr. machine, in contrast to the Swingfog apparatus which requires an automobile battery.

The tests with the Dyna-Fog Jr. machine were conducted at different openings of the insecticide regulating valve. The tests with the Swingfog apparatus were made with the insecticide regulating valve turned fully open; when emulsions were emitted, additional tests were made with the tap opened by one revolution

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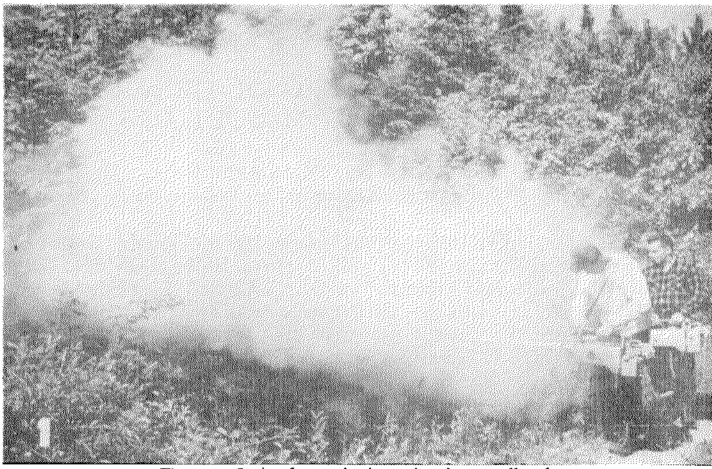

FIG. 1.—Swingfog units in action in woodland.

FIG. 2.—Dyna-Fog Jr. generator in action in woodland.

only. With this latter apparatus, two sets of orifices (at the regulating valve and at the outlet nozzle) were tested, one set being small and the other large, since they afforded two different emission rates of insecticide. The smaller orifices were originally supplied on the machine; the larger ones were drilled by the Canadian distributor (with a No. 60 and a No. 49 wire drill respectively) to increase the emission rate. The diameters, in inches, were as follows:

	Small	Large
cgulating valve	.028	.040
›utlet nozzle	.052	.075

The insecticide materials used in the ·sts were: (a) 5 per cent DDT solution ı fuel oil (Shell Oil Co., Toronto, Ont.); b) 30 per cent DDT concentrate in eavy aromatic oil (Sherwin-Williams ıc., Montreal, P. Q.); (c) 5 per cent DDT mulsion, made by adding 4 parts of water › 1 part of a 25 per cent emulsifiable ›ncentrate (JP-25, John Powell Inc., New ork, N. Y.); (d) 5 per cent DDT solu-on in kerosene (Shell Oil Co., Toronto, ›nt.). All liquid volumes are quoted in ıis paper as imperial gallons (1 imp. gal. = 1.2 U. S. gal.).

METHODS. Emission rates were deter-ıined by putting a known quantity of quid into the insecticide tank, and ascer-ining the time required to expend it ith the machine stationary; 3 to 5 de-rminations were made in each assessment ›r each formulation. Droplet spectra ere assessed by drawing air samples, ken 6 ft. from the machine, through ıscade impactors (Casella) at 17.5 litres :r minute (Brown and Watson, 1953); ith the Swingfog 4 or 5 determinations ere made in each assessment, and with e Dyna-Fog Jr. a single determination as made from 3 cascade impactor sam-es taken. The droplet sizes are reported mass median diameters (m.m.d.) com-ıted by the method of Brown and Wat-n (1953), and in certain representative ses they are plotted as frequency dis-ibution curves.

When the output of these machines was mpled at distances exceeding 50 yd., they ere carried along an emission line 200 l. long and at right angles to the wind. he amounts of DDT that reached vari-ıs distances downwind were sampled ith 9-inch squares of copper screening 3rown and Watson, 1953), and the ma-rial collected by them was analyzed by e Schechter-Haller method. Using two vingfog machines, emitting 5 per cent lution, 0.35 lb. of DDT was applied per o yd. of frontage by covering the 200-l. emission line in 28 minutes at a walking speed of 0.24 m.p.h. One such test was performed over open terrain, using the larger orifices emitting an aerosol whose m.m.d. approximated 15 microns; the wind speed was 6 m.p.h. and there was a very slight upward convection of the air. Six similar tests were performed on the passage of the aerosols through woodland. The oil solutions were tested at Camp Borden, in dense woods of white pine, jack pine, red pine, and poplar with much undergrowth; the emulsions were tested at Petawawa, in open stands of jack pine.

The effects of these aerosols on adult mosquitoes in woodland were investigated at Petawawa, Ontario, between June 9 and 18, with single additional tests performed at Goose Bay, Labrador, and Baie Comeau, P. Q. Specimens collected at Petawawa on June 15 and 16 were *Aedes trichurus* (Dyar), *A. punctor* (Kby.), *A. communis* (Deg.) and *A. intrudens* Dyar. The aerosols were applied at dosages between 0.22 and 0.36 lb. of DDT per 100 yd., from a front 200 yd. long. Tests conducted in the morning and afternoon required the wind speed (as measured in the open) to be 10–15 m.p.h. in order to penetrate the woods, whereas those in the evening were performed when the wind speed was approximately 5 m.p.h. Landing rates were taken at distances of 100, 200, 300, and 400 yd. before and 1 to 2 hr. after the application, by a crew of four men. The average landing rate before treatment, taken on the front of the trousers, was of the order of 15 per minute. Two treatments were compared in each field trial, in order to ascertain the percentage reduction in landing rate. The difference between the means of the 16 percentage reduction values for each pair of treatments was tested by Student's *t* test, the treatment variances not being considered the same and an arc sine transformation having been performed.*

*$t = \frac{X_1 - X_2}{\sqrt{\frac{s_1^2 + s_2^2}{n-1}}}$, where the variance $s^2 = \frac{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}{n-1}$

In an attempt to ascertain the fate of mosquitoes exposed to the aerosol generated by the Swingfog emitting DDT (in 5 per cent solution in fuel oil) at 0.35 lb. per 100 yd., observers stood in the center of white linen sheets at 100, 200, and 300 yd. downwind of the line of emission. Landing rates were taken immediately before, during, and 5 minutes after the aerosol cloud had passed; observations were made on the behavior of the mosquitoes in their natural environment after the passage of the cloud; and at the 200-yd. point a number of specimens were collected, after the cloud had passed, and put individually into separate test-tubes stoppered with cotton wool.

The effects of these aerosols upon blackflies, principally *Simulium venustum* Say, were investigated at Baie Comeau, P. Q., between June 20 and August 8. The aerosols (in 5 per cent solution in fuel oil) were applied at dosages of 0.24 and 0.36 lb. per 100 yd. Landing rates were taken at the stated distances by a crew of four men, utilizing 18-inch squares of dark blue flannel, immediately before and 30 minutes after the treatment. In an attempt to ascertain the fate of blackflies exposed to the aerosol generated by the Swingfog emitting DDT (in 30 per cent concentrate) at 0.20 lb. per 100 yd. of frontage, observers stationed 25 yd. downwind took landing rates before, during, and after the passage of the cloud. Blackflies exposed to the passage of the cloud were immediately collected in sweep nets and transferred to battery jars wrapped in paper, and compared with blackflies simultaneously collected from an untreated area in acetone-cleaned sweep nets and transferred to battery jars which were kept in that area.

Results. The delivery rates and droplet sizes produced by the Swingfog apparatus under various conditions are shown in Table 1. The average emission rate with 5 per cent DDT solution through the original small orifices was 1.5 g.p.h. The use of the larger orifices about doubled the emission rate. The rates obtained were consistent when 5 per cent solution was used, but variable with th 30 per cent concentrate. The rates wer very variable with the 5 per cent emu sion, especially when the regulating valv was fully open; in addition, short stop pages occasionally developed, caused b clots (resulting from a "ropy" emulsion collecting mainly in the insecticide shu off tap. When the insecticide regulatin valve was opened by only 1 turn, th emission rate of the emulsion through th small orifices was slightly reduced bu more consistent. With the oil solutio and oil concentrate emitted through th small orifices, the emission rate with th valve opened by only 1 turn was no le than when it was fully opened. Whe the large orifices were used, opening th valve by only 1 turn restricted the emi sion to 36 per cent of the rate when th valve was fully opened.

The droplet sizes of the aerosols pr duced by the Swingfog from 5 per ce DDT solutions were represented by ave age mass median diameters of 11.0 m crons for the small orifices and 15.2 m crons for the large orifices (Table 1 The droplets obtained with the 30 p cent concentrate were slightly coars With both oil solutions, there was no fa out of coarse droplets (except an occ sional 50-micron droplet) immediately front of the machine; the spray atomiz from the outlet nozzle did not impin on the inside of the fog-mixing tube. Wi the 5 per cent emulsion emitted throu the large orifices, a coarse aerosol of microns m.m.d. offset the advantage the higher emission rate of 3.1 g.p.h. T initial spray impinged on the fog tu and a considerable amount of coarse atomization took place from the edges the tube. With the smaller orifices finer aerosol was produced from the em sion, but there was still some impingeme on the tube; if, however, the regulati valve was opened by only 1 turn, a fi aerosol of 8 microns m.m.d. was obtain at an emission rate of 1.7 g.p.h. This fi degree of atomization is remarkable view of the fact that the temperature the end of the outlet pipe under con

TABLE 1.—Swingfog: emission rates and droplet sizes with various formulations of DDT and adjustments in the apparatus

Formulation and adjustment	Emission rate, g.p.h. Average	Emission rate, g.p.h. Range	Mass median diameter, microns Average	Mass median diameter, microns Range
5% Solution				
Small orifice	1.51	1.40–1.64	10.9	8.6–15.9
Large orifice	3.34	2.23–3.45	15.2	10.2–18.1
30% Concentrate				
Small orifice	1.35	1.10–1.53	11.8	8.6–16.8
Large orifice	2.73	2.50–2.96	18.7	13.0–23.0
5% Emulsion				
Small orifice	2.07	1.54–2.58	16.3	12.8–20.4
Small orifice*	1.70	1.53–1.82	7.8	6.5– 9.1
Large orifice	3.10	2.58–4.80	26.9	18.2–25.0

* Insecticide regulating valve opened by only 1 turn.

tions similar to these is only 65° C. (Cooper Technical Bureau, unpublished report).

The frequency distribution curves of representative droplet spectra are shown in Fig. 3. The curve for the 5 per cent solution was characterized by an extension into the larger droplet sizes. The frequencies for 30 per cent concentrate, and for the 5 per cent emulsion with the valve opened 1 turn, were closely distributed about the mean. When 5 per cent solutions were emitted through large orifices, or 5 per cent emulsions through a fully opened valve, the frequency curve showed a "tail" extending into the large droplet sizes.

The delivery rates and droplet sizes produced by the Dyna-Fog Jr. generator under various conditions are shown in Table 2. Although the machine was capable of emitting 5 per cent DDT solution in fuel oil at 9 g.p.h. with the regulating valve fully open, the atomization was too coarse. When the valve was opened only 3.5 turns (not quite half open), a satisfactory droplet spectrum of 18.5 microns m.m.d. was obtained at an emission rate of 6 g.p.h. The same opening of the valve gave a suitable droplet spectrum with the 30 per cent concentrate at an emission rate of approximately 5 g.p.h. Although it would appear from Table 2 that the 5 per cent solution in kerosene gave a satisfactory droplet size when emitted at full opening, the figure of 15.4

TABLE 2.—Dyna-Fog Jr.: emission rates and droplet sizes with various formulations of DDT and adjustments in the apparatus

	Valve setting, no. of turns from closure				
	3	3.5	4	6	8.5
5% DDT in fuel oil					
Emission rate, g.p.h.	4.6	6.0	7.3	8.6	9.0
Mass median diameter, microns	8.2	18.5	56	78	...
5% DDT in kerosene					
Emission rate, g.p.h.	4.8	5.6	7.8	...	8.9
Mass median diameter, microns	8.9	8.8	12.8	...	15.4
30% DDT concentrate					
Emission rate, g.p.h.	1.7	4.8	5.2	6.8	6.9
Mass median diameter, microns	9.0	11.5	4.1	36	55
5% DDT emulsion					
Emission rate, g.p.h.	3.5	...	6.0	...	...
Mass median diameter, microns	130	...	82	...	...

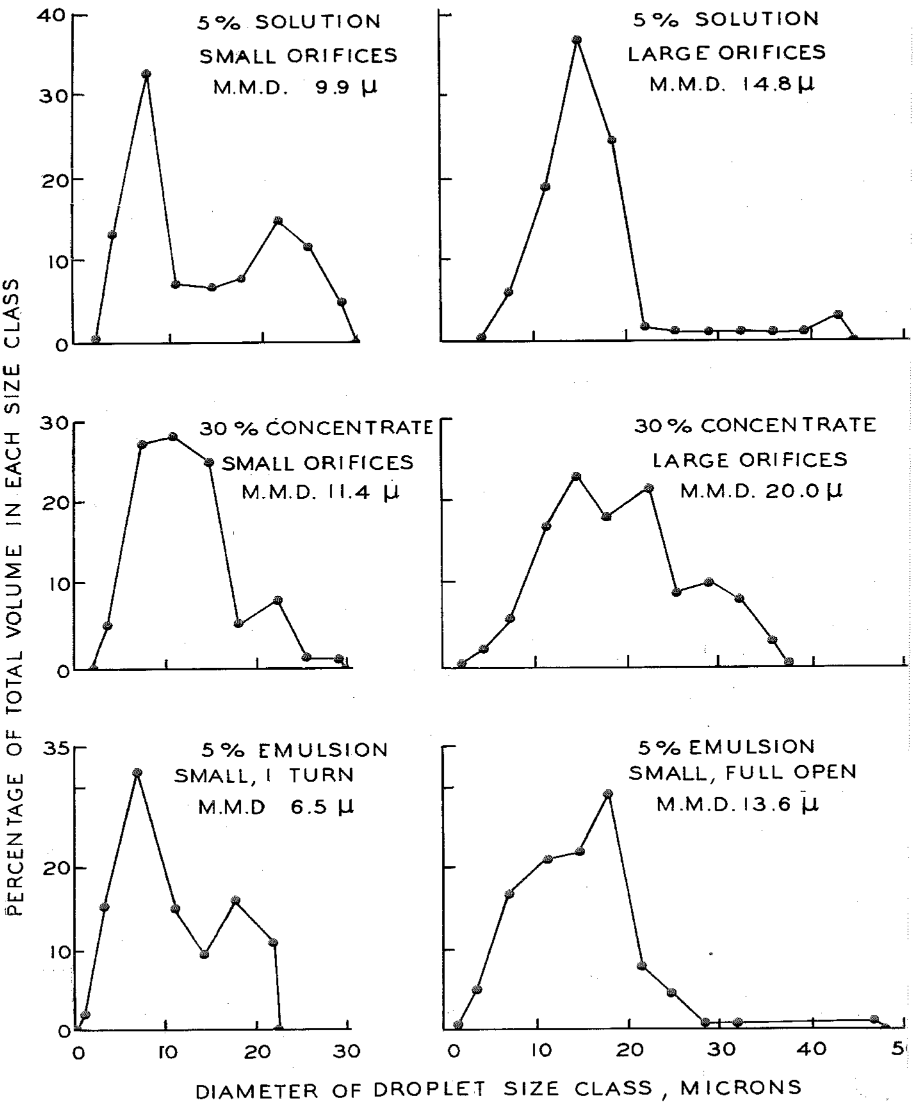

Fig. 3.—Frequency distributions of droplet sizes of aerosols produced by the Swingfog unit from various formulations.

microns for the m.m.d. is misleading since the large droplets in the spectrum were counterbalanced by an excessive amount of extremely small droplets. A droplet spectrum of aerosol size could not be obtained with emulsions, due to impingement on the fog-mixing tube, and progressive reduction in delivery rate if the regulating valve was opened only slightly. As may be seen from Fig. 4, the frequency distribution of droplet sizes from the Dyna-Fog Jr. dispersal system lay in the vicinity of 10 microns; larger m.m.d. values were caused by the appearance of a "tail" consisting of a comparatively small number, but a large aggregate volume, of droplets above aerosol size.

When an aerosol cloud of 15 microns m.m.d. was emitted from the Swingfog over open terrain by the method described

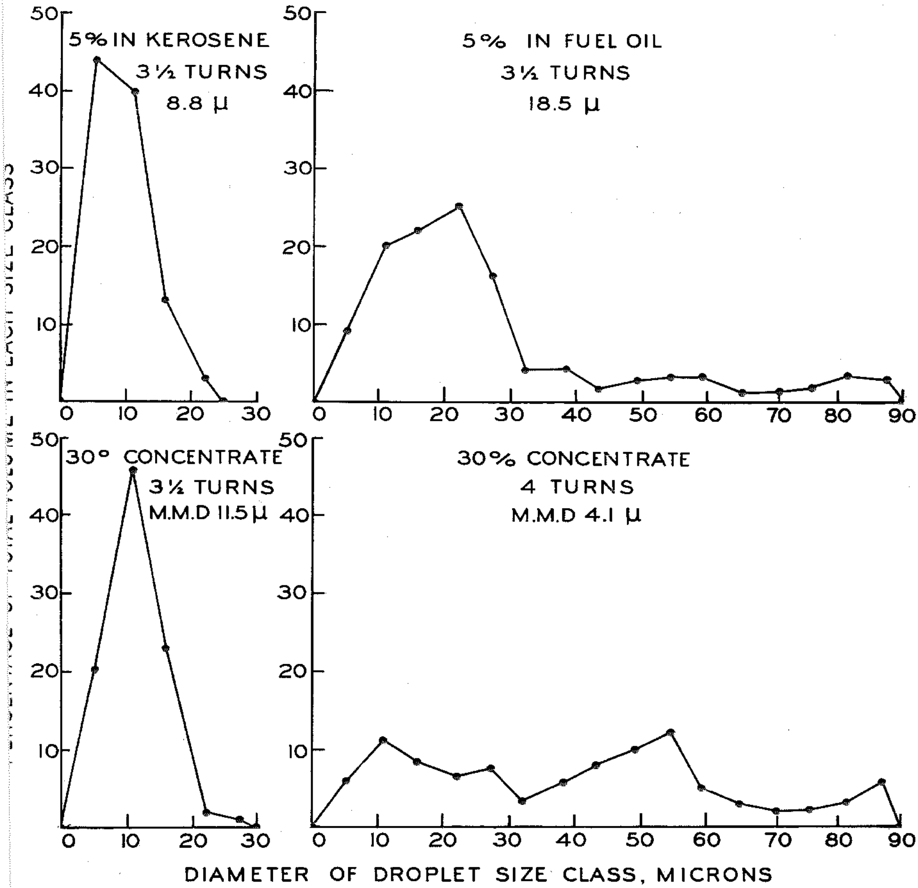

FIG. 4.—Frequency distributions of droplet sizes of aerosols produced by the Dyna-Fog Jr. generator from various formulations.

above, the following droplet sizes and DDT recoveries on 81-sq. in. copper screens were obtained:

Distance downwind, yards	50	100	200	300	400
DDT on screens, micrograms	369	200	205	140	158
Mass median diameter, microns	4.8	7.6	3.8	3.9	4.0

The largest droplets to reach the 50- and 100-yd. points were 12.5 microns in diameter; at the 200-, 300-, and 400-yd. points, 7 microns. At the point of emission, approximately 20 per cent of the volume was in the form of 7-micron droplets or smaller, and approximately 30 per cent as 12.5 microns or smaller.

The recoveries of DDT at various distances downwind of the Swingfog apparatus emitting aerosols through woodland are shown in Table 3. The oil solutions maintained a good level of dosage for 400 yd. when emitted through the small orifices. With the large orifices, however, there was a drop in dosage beyond 50 yd. With the emulsions there was a marked drop in dosage to inadequate levels at distances of more than 100 yd.

TABLE 3.—Recoveries (single determinations) of DDT, in micrograms, at various distances downwind of emission of various formulations from Swingfog unit through woodland

Formulation and orifices	DDT emitted per 100 yd., lb.	Wind m.p.h.	Distance downwind, yards 50	100	200	300	400
5% solution							
Small orifices	0.346	4	75	64	27	119	194
Large orifices	0.346	6	207	93	44	66	61
30% concentrate							
Small orifices	0.340	4	424	224	242	224	46[illegible]
Large orifices	0.345	3	205	56	56	124	20[illegible]
5% emulsion							
Small orifices	0.340	3	30	6	26	54	[illegible]
Large orifices	0.536	3	138	226	14	42	4[illegible]

The percentage reductions in landing rates of adult *Aedes* obtained with the different treatments are shown in Table 4. The average of the reductions obtained up to 400 yd. downwind in the 11 pairs of tests, with dosages between 0.24 and 0.46 lb. per 100 yd., was 72.7 per cent. When the Swingfog apparatus was operated with the regulating valve fully open, and with the large orifices, the 5 per cent solution in fuel oil was superior to the 5 per cent emulsion, the difference between the results of the two treatments being significant at the 1 per cent level; with the small orifices, the difference between the treatments was not statistically significant. If the emulsion was emitted with the regulating valve open only 1 turn, the results were in no way inferior to those with the 5 per cent solution; the apparent superiority of the 5 per cent emulsion in this instance is attributable to the fact that it was emitted over more open terrain than the solution with which it was compared.

The differences in reduction by the 5 per cent solution and the 30 per cent concentrate at parallel DDT dosages were not significant at the 5 per cent level. A single comparison between the Swingfog and the Dyna-Fog, both emitting 5 per cent solution in kerosene, showed a highly significant difference. Unfortunately it was found impossible to repeat this comparison in order to establish whether kerosene solutions were definitely unsuitable in the Dyna-Fog generator. With the 5 per cent solution in fuel oil, the Swingfog with the original small orifice was as effective at parallel DDT dosages, as the TIFA operated at 1,000° F. and 19 g.p.h.; the

TABLE 4.—Percentage reductions (averages of 4 counts) in landing rates after application of various ormulations of DDT with Swingfog, Dyna-Fog Jr., and TIFA machines against *Aedes* mosquitoes in eastern Canadian woodland

DDT ormulation	Orifices or machines	DDT emitted per 100 yd., lb.	Woodland type	Reduction, %, at yd. downwind 100	200	300	400	average
wingfog: solution versus emulsion								
5% solution	Small	0.30	Thick	85	51	58	53	62
5% emulsion	"	0.30	Mixed	81	67	33	23	51
5% solution	Large	0.36	Thick	98	87	85	92	91
5% emulsion	"	0.32	Mixed	99	59	55	58	68
5% solution	Small	0.22	Spruce	91	100	88	67	86
5% emulsion*	"	0.22	Woods	100	100	95	86	95
wingfog: solution versus concentrate								
5% solution	Small	0.24	Open	91	100	95	90	94
30% concentrate	"	0.24	Pine	80	91	83	64	80
5% solution	Small	0.35	Thick	82	99	42	72	74
30% concentrate	"	0.46	Mixed	94	66	81	40	70
wingfog: small orifices versus large								
5% solution	Small	0.24	Thick	62	66	88	73	72
5% solution	Large	0.24	Mixed	87	60	33	73	63
5% solution	Small	0.24	Thick	95	100	71	75	85
5% solution	Large	0.24	Mixed	83	91	82	73	82
wingfog (small orifice) versus Dyna-Fog Jr. (3½ turns)†								
5% in kerosene	Swingfog	0.36	Thick	94	99	97	99	97
5% in kerosene	Dyna-Fog	0.36	Mixed	90	76	22	21	52
wingfog (small orifice) versus TIFA								
5% solution	Swingfog	0.35	High	100	92	63	76	83
5% solution	TIFA	0.35	Pine	100	78	84	89	88
5% solution	Swingfog	0.35	Pine	75	0	0	34	27
5% solution	TIFA	0.32	Undergrowth	22	72	70	68	58
5% solution	Swingfog	0.30	Thick	100	83	51	51	71
5% solution	TIFA	0.28	Mixed	78	70	35	19	51

* Regulating valve open only 1 turn; test performed at Goose Bay, Labrador.
† Test performed at Baie Comeau, Que.

ariation in the last two experiments is ttributable to differences in woodland lensity between the two plots.

The landing rates of mosquitoes taken y observers stationed at various distances lownwind in woodland during the pasage of a DDT aerosol emitted from the wingfog at 0.35 lb. per 100 yd. were as ollows:

	100 yd.	200 yd.	300 yd.
efore passage	8	37	18
During passage	0	21	10
min. after passage	0	7	2

As the aerosol cloud passed, the mosquioes became excessively active and avoided anding on the observers, especially at the oo-yd. point. Three minutes after the assage of the cloud, many disappeared from the air around the observers, the disappearance being total at the 100-yd. point. Many took refuge on the undersurfaces of leaves such as those of alder. At the 100-yd. point, some walked stiffly on the forest floor. One of these was observed continuously; after cleaning her proboscis with the prothoracic legs for 30 min., she showed periodic spasms that lifted her from a crouched position and finally turned her on her back, to die 1 hr. after the passage of the cloud. At the 200- and 300-yd. points, affected mosquitoes alighted, performed cleaning movements, and flew on. Of eight specimens collected into test tubes at the 200-yd. point, three showed toxic symptoms 2.5 hr. later, one dying 5 hr. and two 7 hr. after exposure, rolling and tumbling in the final stages of poisoning; the other five remained normal.

A total of 10 tests were performed to determine the percentage reductions in landing rates of *Simulium* adults obtained 20 to 50 minutes after the passage of a cloud of DDT in oil solution emitted through woodland. The results were extremely variable, ranging from no reduction to 77 per cent reduction. The percentage reductions obtained at the various distances downwind in 5 tests performed at the highest dosage, which was 0.36 lb. per 100 yd., were as follows:

100 yd.		200 yd.		300 yd.		400 yd.		Average	
Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.
3–97	55	0–75	15	0–82	31	0–61	23	1–77	31

Eight of these tests involved a paired comparison between the Swingfog and the Dyna-Fog Jr. at the same dosage of DDT and approximately the same m.m.d. of the droplet spectra. In 3 of these 4 paired comparisons, the Swingfog gave the greater reduction in landing rate.

The average landing rates of blackflies taken by 2 observers stationed 25 yd. downwind in woodland during the passage of a DDT aerosol emitted from the Swingfog at 0.20 lb. per 100 yd. were as follows:

Time from passage, min.	−8	−5	−2	+1	+4	+7	+10	+13
Average landing rate	121	92	149	39	15	45	92	102

The reduction in landing rate in the 10 minutes after the passage of the cloud was observed to be due to the blackflies scattering from the observer and sheltering in foliage.

When blackflies were collected from a treated area and held for observation in battery jars, the following results were obtained on comparing the collections from 3 treated areas with one from an untreated area 3 hours after they were collected:

	Normal	Affected	Dead
Treatment 1	0	17	5
Treatment 2	0	37	0
Treatment 3	0	11	1
Control	17	2	0

All the flies exposed to the aerosols exhibited ataxia in walking movements 1 hr. after exposure. All flies exposed to the aerosols were dead 11 hr. after exposure, at which time all the unexposed flies were still living, although the majority had become motionless.

Discussion. These experiments show that the Swingfog apparatus can emit aerosols that are suitable for controlling woodland mosquitoes. These aerosols have finer droplets than those usually emitted by the TIFA machine. Although the droplet spectrum with fuel oil is bimodal, which bimodality had also been observed by Dr. H. Geffcken, Monthey, Switzerland (personal communication to Devenco Inc., 22 April 1953), it is more compact and consistent than from the other portable jet generator, the Dyna-Fog Jr.; this latter machine characteristically produces a large amount of smoke-size droplets less than 1 micron in diameter, as was noted also for the large Dyna-Fog generator (Brown and Watson, 1953). The Swingfog apparatus is simple to operate and gives little trouble during a total of 50 hours' running time there were only three instances of fire in the fog-mixing tube, resulting from ignition of the DDT solution. The apparatus is portable, but at parallel dosages it gives control equal to that obtained with the TIFA, which requires a vehicle and roads. Nevertheless, the low emission rate of 1.5 g.p.h. with the original small orifices is a handicap for the use of the Swingfog in Canadian woodland. For this reason, the use of the substitute larger orifices to double the emission rate is probably economical, despite the slight decrease in control per pound of DDT emitted. Where speed of treatment is important, the 30 per cent concentrate may be substituted for the 5 per cent solution. The greate emission rate of the Dyna-Fog Jr., which is 3 to 4 times that of the Swingfog as supplied, is a distinct advantage for this generator. Whereas the Swingfog requires an automobile battery for initial ignition, the Dyna-Fog Jr. has a built-in ignition system. However, the lighter construction of the Dyna-Fog Jr. generator makes it less suitable for use under rough conditions in the woods.

Under normal conditions it is more satisfactory to use DDT solutions rather than emulsions, principally because there is no operating difficulty with the former since the insecticide lines remain clear. However, when there is fire hazard in the woods, or where because of transport difficulties only DDT emulsifiable concentrate and no diluent is available, emulsions may be used in the Swingfog but not in the Dyna-Fog Jr. The cloud produced by the Swingfog from emulsions is not spectacular, and its delivery is subject to irregularities and stoppages, but it gives excellent control. These findings are in agreement with those of the Cooper Technical Bureau (unpublished report) that better control of adult house flies may be obtained with emulsions (12.5 per cent DDT, or pyrethrins plus piperonyl butoxide) than with solutions of parallel concentration, provided that the emulsion is emitted with only one-half or one turn of the regulating valve so that no excess liquid impinges on the fog-mixing tube. In tests conducted in Nigeria against adults of *Aedes aegypti* L. in native houses, Elliott and Fitz-John (1953) found that DDT emulsions were no less effective than solutions, but that the relative invisibility of the cloud made it difficult for semi-skilled operators to make the correct application.

The observations made on the fate of mosquitoes exposed to the aerosols do not support the suggestion, arising from work in Alaska by McDuffie *et al.* (1950), that mosquitoes affected by aerosols move to ground level and then return to progressively higher levels. When the dosage of DDT was low and therefore slow in action, the mosquitoes responded instead by seeking secluded spots to rest. Those that still came to man showed no increased preference for the ankles as against the upper parts, although many of them were either excessively active or torpid, depending on the stage of poisoning reached. Of those mosquitoes that land on man after the cloud's passage, a portion are probably due to die within approximately 6 hours, as indicated by these observations.

The results obtained by the application of these aerosols against blackflies were comparable to those reported by Travis (1949) from Alaska, who noted little reduction in numbers immediately after treatment and considered that this was due to the rapidity of infiltration from surrounding areas. Certainly the control obtained with aerosols was not as great as the reduction of 80 to 87 per cent observed after aerial spraying with 10 to 20 per cent DDT in oil solution (Brown, 1952). Although the experiments here reported indicate that DDT aerosols at 0.16 to 0.36 lb. per 100 yd. of frontage eventually kill, or at least hasten the death of, adult blackflies, it is evident that the dosage is insufficient (as suggested by Travis) to kill them within a short space of time. Translated in terms of experience, the application of aerosols at dosages suitable for mosquito control may be expected to achieve on the average a one-third reduction in landing rate of blackflies, assessments of which may range from three-quarters reduction to no reduction at all.

SUMMARY. In producing aerosols for control of adult *Aedes* mosquitoes, the Swingfog portable jet apparatus emitted 5 per cent DDT in fuel oil at 1.5 g.p.h., the droplet spectrum having a mass median diameter of 11 microns. With 30 per cent concentrate the emission rate was 1.4 g.p.h. and the m.m.d. 12 microns. With 5 per cent emulsion the rate averaged 2.1 g.p.h. and the m.m.d. 16 microns; when the regulating valve was opened by only 1 turn, the emission rate was 1.7 g.p.h. and the m.m.d. 8 microns. An increase of approximately 50 per cent in

orifice size about doubled the emission rates and increased the droplet sizes by approximately 60 per cent.

When DDT aerosols were emitted at dosages between 0.22 and 0.36 lb. per 100 yd. of frontage, the reduction in landing rate of mosquitoes for 400 yd. downwind averaged 73 per cent, the average reduction in any one test ranging from 27 to 97 per cent. At parallel DDT dosages, the differences in the reductions in landing rates from the 5 per cent solution and the 30 per cent concentrate were not statistically significant. Results with the 5 per cent emulsion were significantly inferior to those with the solution when emitted at full volume, but when the regulating valve was opened by only 1 turn the results were not inferior. At parallel DDT dosages, the 5 per cent solution emitted from the Swingfog apparatus gave as good reduction as when emitted from the TIFA machine, although a much longer time was consumed in application.

The Dyna-Fog Jr. portable jet generator emitted 5 per cent DDT in fuel oil at 6.0 g.p.h., the droplet spectrum having a m.m.d. of 18.5 microns, if the regulating valve was opened by 3.5 turns. At this setting it emitted 30 per cent DDT concentrate at 4.8 g.p.h. with a m.m.d. of 11.5 microns. With 5 per cent emulsion the droplets were too large and the emission rate progressively decreased.

At dosages of 0.36 lb. DDT per 100 yd. of frontage, aerosols from these jet generators achieved reductions of landing rates of adult *Simulium* blackflies that averaged 31 per cent for 400 yd. downwind. However, the average reductions in any one test ranged from 1 to 77 per cent.

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Erratum

In the description of the Alaska Aerosol Atomizer in the paper by Brown and Mulhern, in Volume 14, No. 4 (December, 1954), the first sentence of column 2, p. 185 should read ". . . a 0.63 mm. tip emits the insecticide opposite a 1.95 mm. air orifice" instead of 2.7 mm. and 5.4 mm. respectively as originally stated.—A. W. A. Brown.