Aerial Application of Larvicides for Control of *Simulium damnosum* in Ghana: a Preliminary Trial

by H. A. JAMNBACK,[1] T. DUFLO[2] & D. MARR[3]

A study carried out in November and December 1968 indicated that aerial application of *Simulium* larvicides in West Africa was feasible and it was recommended that a pilot trial be made.[4] Northern Ghana was selected as the best area for the trial because it has many reasonably accessible sites where *S. damnosum* may be found. There is an onchocerciasis control unit in the area, a serviceable airstrip nearby, and a spray aircraft is available.

The objectives of the trial were to evaluate the effectiveness of *Simulium* larvicides applied by aircraft and to determine the dosage levels and concentrations required for effective control under West African conditions. Two insecticides, DDT and methoxychlor, were selected for testing.

Spray aircraft used in trial

A Beaver DC 2 aircraft, belonging to the Ghana Air Force, equipped with spray booms mounted under the wings, Spraying Systems nozzles, a wind-driven Simplex spray pump and a 200-UK gal (900-litre) spray tank was used in the trials which were carried out between 9 and 24 November 1969.

The equipment was first calibrated to deliver 1 US gal (3.8 litres) per flight-mile (1.6 km) flying at 90 mi/h (145 km/h). Later three more nozzles were added to deliver a total of 2 US gal (7.6 litres) per flight-mile (1.6 km). The swath width was approximately 100 ft (30 m). The total number of flying-hours for the trial including the time taken to reach the site, to calibrate the equipment, and to apply the spray was 23 hours.

The insecticides were applied by flying swaths across the rivers just above the breeding site or flying one or more swaths along the length of rivers beginning near the top of the rapids and continuing for 10 or 12 seconds (about one-quarter mile, i.e., 400 m) upstream. The dosage was determined by the width of the river just above the breeding site rather than by volume of water in the river. The usual altitude of the aircraft during spraying was about 50 feet (15 m) or just above the trees bordering the river.

Insecticides and formulations tested

The DDT and methoxychlor formulations were purchased in New York State, USA,[2] and are identical to those which have been used there to control *Simulium* larvae. The DDT was made up in a 20% solution (solvents HAN 132 and fuel oil) with 0.5% Triton X-161. A 15% methoxychlor solution with 0.75% Triton X-161 and a 15% methoxychlor emulsifiable concentrate containing 1.0% Triton X-161 were also tested.

The three formulations behave quite differently when sprayed into water. The 0.5% Triton formulation penetrates the water and then quickly reappears as an iridescent oil-slick on the surface; the 0.75% formulation reappears as a mosaic of discrete, small, irregular, slightly milky slicks at the surface; the 1.0% formulation mixes into the water immediately forming an emulsion that disappears in turbulent water.

Methods of evaluation

Plus sings were used to indicate larval abundance; ++++ indicated a superabundance of larvae, often occuring in solid masses of more than one layer; +++ indicated that larvae were abundant, dozens being found on a single blade of grass, leaf, or stone; ++ indicated that larvae were moderately abundant, about 6 per attachment unit; + indicated that larvae were common, most blades of grass, leaves, or stones having 1 or 2 larvae.

Pretreatment larval population estimates were made just before treatment and post-treatment estimates the following day.

[1] New York State Museum and Science Service, Albany, New York, N.Y., USA.

[2] Duflo Spray-Chemical Co., New Bremen, New York, N.Y., USA.

[3] WHO Onchocerciasis Advisory Team, Project AFRO-0131.

[4] Jamnback, H. A. & Higgins, A.E.H. (1969) *The feasibility of aircraft spraying for* Simulium *larval control in West Africa.* An unpublished WHO document, VBC/69.5. A limited number of copies of this document is available to persons officially or professionally interested on request to Distribution and Sales, World Health Organization, 1211 Geneva, Switzerland.

Results

The results of the trials of 20% DDT solution applied by aircraft in Ghana are summarized in Table 1. It can be seen that concentrations of less than 0.01 ppm (based on 30-min exposure time) are effective.

The results of the trials with 15% methoxychlor solution are summarized in the first half of Table 2.

TABLE 1
AERIAL APPLICATION OF 20% DDT SOLUTION FOR *SIMULIUM* LARVAL CONTROL

Stream	Date treated	Width (ft) [a]	Swath pattern	Flow (ft^3/sec) [b]	No. of US gal [c] applied	Concentration (ppm/30 min)	Numbers of larvae [d]	
							Pre-treatment	Post-treatment
Applied at the rate of 1 US gal per flight-mile								
Kurkurugu	12 Nov.	132	1 across	330	0.025	0.001	+ + +	+ + +
Nangodi	12 Nov.	132	2 across	210	0.05	0.004	+ +	very rare [e]
Zongoiri	12 Nov.	257	1 upstream (12 sec)	576	0.30	0.008	+ + +	rare
Applied at the rate of 2 US gal per flight-mile								
Kurkurugu	14 Nov.	132	2 across	330	0.10	0.005	+ + +	+
Morago	14 Nov.	52	2 across	210	0.04	0.003	+ +	rare [f]

[a] 100 ft = 30.5 m.
[b] 1 ft^3/sec = 28.32 litres/sec.
[c] 0.1 US gal = 3.78 litres.
[d] + + + + = extremely abundant: + + + = very abundant: + + = moderately abundant: + = common.
[e] Prepupal stage only.
[f] The few remaining larvae were found at the upper end of the rapids.

TABLE 2
AERIAL APPLICATION OF 15% METHOXYCHLOR SOLUTION AND EMULSION FOR *SIMULIUM* LARVAL CONTROL AT THE RATE OF 2 US gal PER FLIGHT-MILE

Stream	Date treated	Width (ft) [a]	Swath pattern	Flow (ft^3/sec) [a]	No. of US gal [a] applied	Concentration (ppm/30 min)	Numbers of larvae [a]	
							Pre-treatment	Post-treatment
Solution								
Pwalagu	17 Nov.	240	2 across	700	0.18	0.003	+	+
Arigu	17 Nov.	60	2 upstream (23 sec)	950	1.15	0.013	+ + +	few [b]
Pasinkpe	17 Nov.	250	2 upstream 1 across (40 sec + 1 across)	1 000	2.10	0.023	+ + +	rare [b]
Kurkurugu	24 Nov.	132	3 upstream (30 sec)	170	1.50	0.098	+ + + +	very rare
Emulsion								
Nangodi	19 Nov.	132	1 across	95	0.05	0.006	+ +	+ +
Zongoiri	19 Nov.	354	3 upstream (30 sec)	430	1.50	0.039	+ + +	very rare [c]
Kurkurugu	22 Nov.	132	2 upstream (20 sec)	230	1.00	0.048	+ + + +	+ + + +
Sekoti	19 Nov.	100	1 upstream (10 sec)	95	0.50	0.059	+ + +	very rare [c]

[a] See Table 1.
[b] At Arigu, a few larvae were present at upper end of rapids; at Pasinkpe, there was no reduction at the upper end of the breeding zone (rapidly flowing but non-turbulent water).
[c] Prepupal stage only.

It can be seen that concentrations of about 0.01 ppm/30 min and 0.02 ppm/30 min were effective, except that some larvae at the upper ends of the rapids survived. At a concentration of 0.1 ppm/30 min larvae were almost entirely eliminated from one end of the rapids to the other. The methoxychlor oil solution was lighter and less effective than the DDT oil solution. A heavier methoxychlor solution would probably be more effective in eliminating larvae at the upper ends of rapids than the one used.

The results of the trials with 15% methoxychlor emulsion are summarized in the second half of Table 2. It can be seen that the degree of effectiveness was variable at concentrations of about 0.05 ppm/30 min and often poor at lower concentrations. It seems likely that a concentration of at least 0.1 ppm/30 min would be required for consistently effective control, i.e., the same concentration as required for control by ground application techniques.

Discussion

In the tests described above, methoxychlor solution was more effective at lower concentrations than methoxychlor emulsion. The greater effectiveness of insecticide solutions as compared with emulsions for blackfly larvicides applied by aircraft has also been reported elsewhere (Jamnback & Means, 1968). Oil solutions of insecticide in water are also generally less injurious to stream fauna than emulsions. Both DDT and methoxychlor in oil solutions kill *Simulium damnosum* prepupae as well as young larvae, which is often not the case with DDT emulsions.

The data presented, though limited, indicate clearly that both DDT and methoxychlor solutions applied by aircraft effectively reduced *Simulium* larval populations under conditions prevailing in Northern Ghana.

The most striking advantage of aerial application of larvicides as compared with ground treatment is the rapidity with which breeding sites can be treated. For example, all of the 30–40 dry-season breeding sites of the White Volta drainage system, encompassing an area of more than 10 000 mi² (26 000 km²), could be treated in about 5½ hours using the relatively slow Beaver aircraft that has a cruising speed of 95 mi/h (152 km/h). A faster twin-engined aircraft could treat these same sites in about 2½ hours. In contrast, weekly treatment of these sites using hand application methods would require 5 teams of 6 men each with Land Rovers.

A further advantage of using aircraft is that breeding sites can be detected and mapped from the air. (While it requires about 1 year for an entomologist to survey and map the breeding sites in 100 miles (160 km) of river from the ground, using aircraft the same breeding sites can be detected and mapped in a few hours per month.) These sites are often difficult and sometimes impossible to reach from the ground and may change from one year to the next or during the course of the dry season. Since successful dry season control is based on the premise that breeding must be entirely eliminated within the control zone, it is essential that every site be detected and treated.

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