グァテマラにおけるテメホス剤を用いた広域でのブユ防除法の検討

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Effect of temephos against the blackfly larvae in stream tests in Guatemala[1]

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Abstract: In order to investigate an effective control method of blackfly larvae in an onchocerciasis endemic area of Guatemala, large scale stream tests were done in the rainy season using various formulations of temephos. The concentration of temephos had no relationship with its carry within a range of 0.2–2.0 ppm/10 min. There existed a clear tendency in that the larger the water discharge, the longer was the carry of the insecticide. No distinct difference was observed in efficacy among the four formulations, *i.e.* solid, water dispersible powders (wdp), emulsifiable concentrates (EC) and oil solution, as also between the two application methods, instantaneous pouring and pouring during a 10 min period. It is recommended that in future vector control operations of Guatemalan onchocerciasis temephos wdp packed in a bag containing 1.0–1.5 g of the active ingredient should be poured into a stream immediately after mixing it with stream water, regardless of the water discharge of stream. With this mode of application, 50–100 m carry would be expected in streams infested with *Simulium ochraceum*, the principal vector of onchocerciasis.

INTRODUCTION

The first control trial of blackfly larvae in the world was made by Fairchild and Barreda (1945) in Guatemala. Lea and Dalmat (1955) investigated the effect of DDT in small streams, where *Simulium ochraceum*, the principal vector of onchocerciasis in Guatemala, bred. Since then, no investiga-

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tions were made on control of onchocerciasis vectors in Guatemala until 1976, when the Guatemala-Japan Cooperative Project on Onchocerciasis Research and Control was established. In this project, a control trial of blackfly larvae using temephos (Abate®) was initiated in 1979 in Lavaderos, a small valley in the Pilot Area, subsequent to the preliminary insecticide studies done by Tabaru *et al.* (1982). The trial was successful (Nakamura *et al.*, 1981; Takaoka *et al.*, 1981), but modification of the control method was considered inevitable in the next target area, the Guachipilin River Basin, because of steepness of its terrain, the vast number of target streams, and in particular, of marked fluctuation of water discharge in the streams. Therefore, prior to the forthcoming overall control operation, extensive stream tests using temephos were conducted in Guachipilin, in order to obtain information on the formulation of choice, the adequate dose and carry of the insecticide. One of the objectives also was accumulation of experiences on operational maneuvers and familiarizing of the field staff with onchocerciasis vector control program. These tests were carried out during the rainy season, June to September 1980.

Materials and Methods

(1) Study sites and operation procedures

The Guachipilin Valley is located in the southern slopes of the Sierra Madre Mountains. The elevation range is 700 m to 1,400 m above the sea level. The area is approximately 15 km² with numerous streams, the total length of the streams being as long as 36 km (Fig. 1). There are 380 waterfalls, 36 of them being more than 10 m high. The valley is mostly covered by dense jungles, which makes difficult approach of the field staff to the desired sites along streams, particularly those located near headsprings. The predominant species in the test streams as known were *S. ochraceum*, followed by *S. metallicum*, *S. callidum* and *S. horacioi* (Suzuki, 1983). Due to operational reasons, not all the streams with actual or potential breeding of *S. ochraceum* larvae were treated in the area. It was proposed to treat each stream once in four weeks, since larval densities usually recovered after four weeks of previous application. Each stream was arbitrarily divided into a number of stream-sections, each of which formed one test section. Prior to treatments, the water discharge was measured at two or three points along each stream-section by transferring water flow into a polyethylene bag for 3 sec. The insecticidal dosage was calculated based on maximum discharge in the section. At the same time, larval survey was made on natural substrates in the full stretch of each stream-seciton. At each section-head, a scheduled dose of temephos was applied. After 24 or 48 hours of application, post-control larval survey was made to evaluate the effect of the toxicant. Of a total of 890 sections under the temephos applicaiton, the effect of larvicide was evaluated in 542 sections, in which larval breeding was confirmed in the pre-control survey. The total length of the streams under study was 54 km, of which 3% were with less than 0.1 l/sec water discharge, 28% in the range of 0.1–0.9 l/sec, 53% in the range of 1.0–9.9 l/sec, and 16% with 10 l/sec or more.

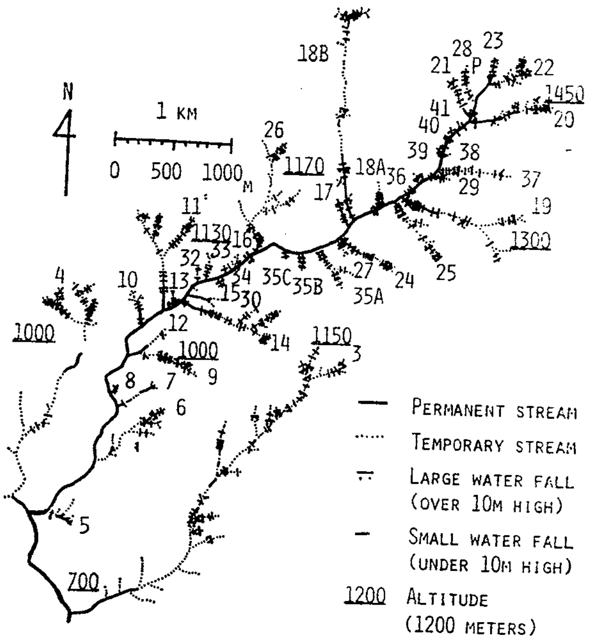

Fig. 1 Map showing streams of the Guachipilin River Valley.

(2) *Temephos formulations and their applications*

Altogether four temephos formulations, *i.e.* solid, water-dispersible powders (wdp), emulsifiable concentrate (EC) and oil solution, were used in the study. The solid type was first used in the Lavaderos trial with good results (Nakamura *et al.*, 1981; Takaoka *et al.*, 1981). The formulation used in the present studies was one modified by Matsuo (in press). This consisted of 120 g 5% temephos wdp, 40 ml Tween 20 and 40 ml water, divided into 30 equal pieces, each containing 0.2 g of the toxicant. Pieces of the solid wrapped in a 15-mesh wire-screen were hung in the running water of each test stream. The number of pieces in a screen were decided, depending on the water discharged and the dose desired. In preliminary tests, the solid was confirmed to dissolve in running water approximately in 10 min. Temephos wdp (5% or 50%) and EC (5%), both commercial samples, were used either by instantaneous pouring or a 10-min pouring after mixing with stream water. The oil solution (2.2%) was prepared by dissolving a 88% technical grade temephos in kerosene, and applied immediately.

Results

Results of the tests are shown in Table 1. Of 542 stream sections under the tests, 122 (22%), 162 (30%), 220 (41%) and 38 (7%) were tested with solid, wdp, EC and oil solution, respectively. Mean distance of all the sections under tests was 99 m.

According to the status of residual larvae after application, the 542 test-sections were divided into the following three categories: First category—no larvae were found in the full stretch of the stream (389 sections); second category—larvae disappeared immediately at downstream sites, but a few remained further downstream (65 sections); and third category—larvae were found immediately downstream (88 sections). For easy reference, a schema illustrating each category is shown in Fig. 2.

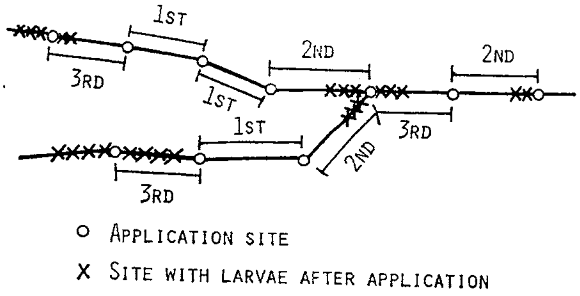

Fig. 2 A schema illustrating each category section in a stream system.

Insecticidal carry could be estimated only in the second-category sections. The overall mean length of these sections was 189 m, and mean effective distance, or insecticidal carry, was 127 m. In the first category sections, the mean length was 86 m, which is far shorter than that of the second category. In the first category, the larvicide was effective in the full stretch of the stream, which make estimate of the insecticidal carry impossible. Of 88 sections belonging to the third category, larvae existed upstream in 58 sections before application, but did not exist in 5 sections. In the remaining 25 sections, it was not confirmed. Excluding the unconfirmed 25 cases, 92.1% (58/63) were found positive with upstream larvae. Therefore, re-attachment of the larvae to the once-cleared downstream sites during one or two days of application was strongly suspected. Of 542 sections under study, 88 (16.2%) belonging to this section were ineffective. If re-attachment is assumed in 92.1% of these sections as stated above, true ineffective cases are only 1.3% (16.2%×0.079) of all the sections tested.

Information on insecticidal carry was obtained from tests in the second-category sections, which is stated below. As shown in Table 1, no marked difference in effective distance was observed among the four formulations tested. The mean effective distance with each formulation ranged 111–151 m, with overall mean of 127 m. Therefore, further analysis was made after combining all the data, regardless of the formulations used.

It is considered that two factors, larvicide concentration and water discharge of the streams, may be responsible for larvicidal carry. The correlation between the larvicidal carry in metre and the concentration in ppm

Table 1 Results of stream tests with temephos.

Item	Formulation				Overall
	Solid	Wdp	EC	Oil	
First-category sections[1]					
No. of sections	96	119	146	28	389 (71.8%)
Mean distance (m)	85	106	65	114	86
Second-category sections[2]					
No. of sections	16	15	29	5	65 (12.0%)
Mean distance (m) of all sections	207	163	198	166	189
Mean effective distance (m)	151	121	111	130	126
Third-category sections[3]					
No. of sections	10	28	45	5	88 (16.2%)
Overall					
No. of sections	122	162	220	38	542 (100%)
Mean distance (m)	99	112	83	129	99

[1] No larvae were found in the full stretch.

[2] Larvae disappeared at immediately downstream sites, but some remained further downstream.

[3] Larvae were found immediately downstream.

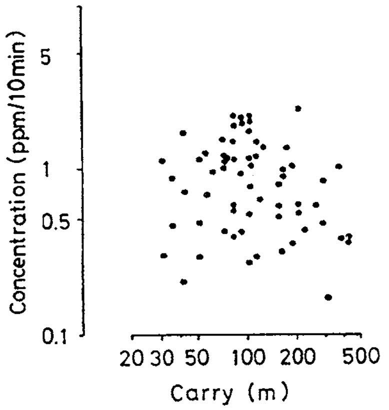

Fig. 3 Relationship between insecticidal carry in metre and temephos concentraiton in ppm/10 min.

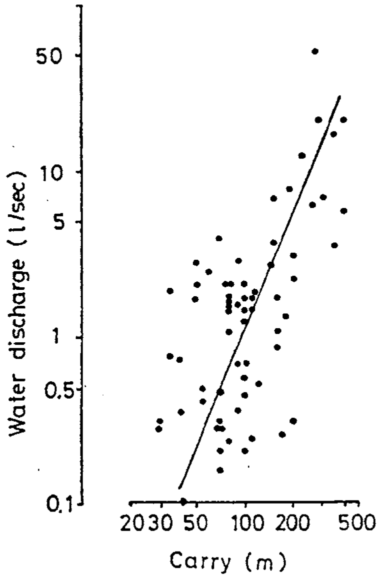

Fig. 4 Relationship between insecticidal carry in metre and water discharge in *l*/sec.

per 10 min, and that between the carry and the water discharge in *l*/sec are shown in Figs. 3 and 4. There existed no correlation between the carry and the concentration; whereas a positive correlation was found between the carry and the discharge.

An idea of the "Absolute Dose" is introduced, which is calculated by the formula: (Absolute Dose) = (Concentration in ppm/min) × (Water Discharge in *l*/sec) × 0.6. This value represents actual amount of the toxicant applied in the unit of gram of active ingredient (g, *a.i.*). The relationship between the absolute dose and the carry is demonstrated in Fig. 5. As expected, clear positive relationship was observed again between the above two factors. This reveals the fact that the more absolute dose of temephos is applied, the longer carry is expected, irrespective of the larvicide concentration expressed by ppm per unit time. This may result in a new approach to the control strategy, applying a fixed dose of temephos irrespective of water discharge. In the present studies, larvae were eliminated in the range of 60–140 m downstream from the dosing site by the application of 1.0–1.5 g, *a.i.* temephos, as shown in Tables 1, 2 and Fig. 5.

Further analysis was made on the carry in relation to the concentration and the dose, by dividing the above three factors into arbitrary ranges, which is shown in Table 2. Peculiar results were obtained on the relationship between temephos concentration and insecticidal carry. Mean carry was 165 m with less than 0.5 ppm/10 min application, 130 m in the range of 0.5–1.0 ppm/min, and 101 m with more than 1.0 ppm/10 min. Insecticidal carry apparently decreased as the concentration increased. This could be due to the bias in number of the test sections: Low concentration tests were made more in larger streams; and higher concentration tests were done more in smaller streams. For example, with the lowest concentration (<0.5 ppm), only three test were made in the smaller discharge sections (<1.0 *l*/sec), whereas 15 tests were made in the larger discharge sections (≥1.0 *l*/sec), which is shown in the left half of Table 2. With the medium concentration (0.5–1.0 ppm), 6 tests were made in the smaller discharge sections, and 13 in the larger discharge sections. With the highest concentration (>1.0 ppm), 17 tests were made in the smaller discharge sections, and 11 in the larger discharge sections.

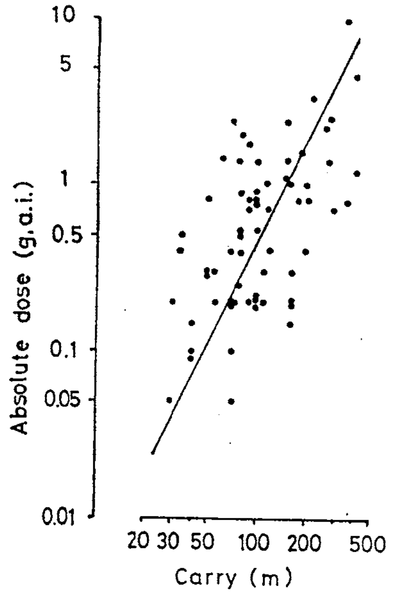

Fig. 5 Relationship between insecticidal carry in metre and absolute dose of temephos in g, *a.i.*

The relationship between the absolute dose and the carry is shown in the right half of Table 2. Careful observation of the results, particularly those with the dose range of 0.5–1.5 g, *a.i.*, revealed that the carry was rather consistent in the smaller discharge section (<2 *l*/sec), but it increased in the larger discharge sections (>2 *l*/sec).

Apart from the factor of small water discharge, shorter carry of temephos than expected was observed in general, under particular conditions of the streams, *i.e.* (1) below a submerged portion, (2) below a water-fall, (3) in muddy streambed with

Table 2 Mean carry of temephos in relation to the toxicant concentration and water discharge, and to the toxicant dose and water discharge.

Water discharge (*l*/sec)	Concentration (ppm/10 min)						Absolute dose (g, *a. i.*)			Overall
	<0.5		0.5–1.0		>1.0		<0.5	0.5–1.5	>1.5	
<0.5	50 (2)	(3)	62 (3)	(6)	88 (14)	(17)	79 (18)	100 (1)	—	80 (19)
0.5–0.9	40 (1)		98 (3)		103 (3)		91 (5)	95 (2)	—	92 (7)
1.1–1.9	89 (6)	(15)	107 (5)	(13)	107 (6)	(11)	100 (5)	104 (10)	85 (2)	101 (17)
2.0–4.9	167 (3)		152 (5)		75 (4)		50 (1)	144 (10)	70 (1)	130 (12)
5.0–9.9	297 (3)		205 (2)		—		—	350 (2)	200 (3)	260 (5)
≥10	300 (3)		280 (1)		350 (1)		—	280 (1)	313 (4)	306 (5)
Overall	165 (18)		130 (19)		101 (28)		84 (29)	143 (26)	224 (10)	127 (65)

Figures outside parentheses show mean carry of temephos in metres; and those inside show the number of stream sections under test.

slow flow, (4) with thick vegetation, and (5) with volume of deposits like fallen leaves or twigs in the streams.

DISCUSSION

Lea and Dalmat (1955) reported after their extensive stream tests in Guatemala that within a certain range of the discharge, the greater the volume of the streams, the greater the distance of complete larval control by DDT. Umino *et al.* (1983), also working in Guatemala, stated that the effective distance would depend on the amount of water discharge and that in minute streams the carry could not be extended by increase of temephos dose. Our finding was more definite in that the concentration (expressed by ppm/unit time) had no relationship with the carry of temephos in the streams under tests. It was confirmed that the water discharge influenced exclusively the insecticidal carry; the larger is the discharge, the longer is the carry. As a matter of fact, the absolute dose (expressed by g, *a.i.*) is correlated with the carry, expressed as the function of toxicant concentration and water discharge. It is suggested, therefore, that for larvicidal control of blackflies in small streams, the absolute dose (g) should be assigned as the indication of the dosage, instead of the concentration.

In the test during dry season in Guatemala (Umino, personal communication), all larvae disappeared within a few hours after a temephos application, but a considerable number of large larvae were found on the following day within 30 m below the application point. Since the upstream portion was infested with larvae, drifting was the only reason for the explanation. In most cases (92%) of the seemingly effective cases in the present study, larval presence at upstream sites was confirmed. This is considered to be due to larval drifting to the once-cleared downstream sites.

Comparison of efficacy among the four temephos formulations failed to prove any difference. From the operational point of view, the water dispersible powders (wdp) should be the formulation of choice, because of its lightness, easiness in transporting and handling, and of safety in accidental breakage of the package. Since no difference was observed also in efficacy of wdp between the immediate pouring and 10-min pouring, instant pouring after mixing it with stream water, is preferable.

For practical vector control in Guatemala, it is suggested that the predetermined dose of temephos wdp should be applied in each target steam by instant pouring method, regardless of water discharge of the stream. Based on the results presented herewith, the recommended dose is 1.0–1.5 g, *a.i.*, and the recommended interval of the two adjacent application sites in a stream is 50–100 m, according to stream conditions. This control system would simplify and assist the operation tremendously, as in this system, laborious measurement of water discharge at each application site is not necessary. The field staff should bring premeasured and prepacked insecticide and simply apply it at each fixed site. It is necessary to remind here that in the vector control operation of Guatemalan onchocerciasis, efficient utilization of manpower is an essential component to be taken into account, because field staff should visit periodically a large number of dosing sites scattered extensively in the rigid mountain terrains.

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REFERENCES

Fairchild, G. B. and E. A. Barreda (1945): DDT as a larvicide against *Simulium*. *J. Econ. Entomol.*, **38**: 694–699.

Lea, A. O. and H. T. Dalmat (1955): Field study on larval control of black flies in Guatemala. *J. Econ. Entomol.*, **48**: 274–278.

Matsuo, K.: Aplicación de larvicida sólido de temefos en el control de la oncocercosis en Guatemala. *Bol. Sanit. Panamer.* (in press)

Nakamura, Y., Y. Yamagata, H. Takaoka, M. Takahashi, J. O. Ochoa A., P. A. Molina and H. Takahasi (1981): A control trial of the vector of onchocerciasis, *Simulium ochraceum*

(Diptera: Simuliidae) in the Lavaderos River Valley, Guatemala. *Jpn. J. Sanit. Zool.,* **32**: 51–58.

Suzuki, T. (1983): *A guidebook for Guatemalan onchocerciasis (Robles disease) with special reference to vector control,* 156 pp., Guatemala-Japan Cooperative Project on Onchocerciasis Research and Control, SNEM, Guatemala.

Tabaru, Y., Y. Nakamura, J. O. Ochoa A., P. A. Molina and H. Takahasi (1982): Preliminary field study on larvicide formulations for onchocerciasis vector control in Guatemala. *Jpn. J. Sanit. Zool.,* **33**: 369–377.

Takaoka, H., J. O. Ochoa A., M. Takahashi and H. Takahasi (1981): Evaluation of temephos as a larvicide against *Simulium ochraceum* (Diptera: Simuliidae) in Guatemala. *J. Med. Entomol.,* **18**: 145–152.

Umino, T., T. Suzuki and J. O. Ochoa A. (1983): Insecticide studies in vector control of Guatemalan onchocerciasis 1. Short carry of temephos in minute streamlets. *Jpn. J. Sanit. Zool.,* **34**: 213–219.

摘　要

グァテマラにおけるテメホス剤を用いた広域でのブユ防除法の検討

グァテマラのオンコセルカ症流行地域における媒介ブユ幼虫の防除方法を改良する目的で，テメホスの各種剤型を用いて，雨季にグアチピリン水系で広範囲にわたる野外実験を行った．その結果，0.2～2.0 ppm/10 min の範囲では有効距離に薬剤濃度は無関係で，流水量が関係していた．テメホスの固型剤，水和剤，乳剤，油剤の間，および瞬時投入と10分間投入との間には顕著な差は認められなかった．したがって，グァテマラにおけるオンコセルカ症媒介ブユ対策の作業は，テメホス水和剤 1.0～1.5g 入りの袋を流水量とは無関係に，50～100 m おきに瞬時投入するのが適切と考えられた．