MUNICIPAL LARVICIDING PROGRAMS WITH TEMEPHOS TO CONTROL EARLY AND MID-SEASON MOSQUITOES IN ONTARIO, 1974–80

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ABSTRACT. Between 1974–80, 12 municipal mosquito abatement programs at five locations across Ontario were monitored for larval mosquito survival and persistence of temephos. Breeding pools were checked for the production of spring *Aedes* species in April and early May and one site for *Culex* and summer *Aedes* in July. Where larval numbers exceeded 30 per 0.57 liter in the second or third instar, treatment with temephos was carried out. In those localities where less than 100 ha were involved, ground application was carried out; where areas to be treated exceeded 1000 ha, a helicopter was employed. Control in most cases was 100%. Initial residues of temephos in water ranged from 1 to 220 μg/liter and declined rapidly over the first 24 hr period. Residues in sediments increased over the first 24 hr to levels between 0.1 and 11 mg/kg and then declined over the next 7 to 10 days.

The current methods of applying temephos as a mosquito larvicide by trained and licensed personnel, resulted in residue levels in mosquito breeding habitats that were both biologically active and environmentally acceptable within the local mandate for safe, effective mosquito control.

INTRODUCTION

Mosquitoes are not only a source of discomfort to many Ontario residents during the spring and summer months but are responsible for outbreaks of St. Louis encephalitis. Hence there has been an increasing public demand for control of these insects. The genus *Aedes* is the greatest source of human irritation while the virus causing encephalitis has been isolated from *Culex* and in particular *Cx. pipiens* (Linn).

Eggs of the more common *Aedes* species develop not only in woodland pools, but also in roadside ditches or open pasture areas. At the onset of snow melt usually in early to mid-April they hatch into larvae. Pupation usually occurs during early and mid-May in central and southern Ontario. Adults emerge from mid- to late May and the biting incidence peaks between mid- to late June and decreases significantly by mid-July, except in the bush areas of central Ontario where cool moist weather may prolong adult longevity. Eggs laid by this generation remain dormant until the following spring.

Summer *Aedes* mosquitoes [predominantly *Ae. vexans* (Meigen) and *Ae. dorsalis* (Meigen)] overwinter as eggs which develop in the presence of warm flood water after temporary drying. The first generation of larvae appears between mid-May and early June in central and southern Ontario. Up to five generations may hatch during the summer. A typical breeding site is an open grassy pool where rainfall will collect for 7–10 days. The first abatement program conducted in 1974 was in the form of a pilot project (MacKenzie 1974[3]). Thereafter, the physiography of each abatement area was surveyed and mapped prior to treatment. Following the September 1975 outbreak of St. Louis encephalitis in southwestern Ontario, the basic plan for larval mosquito control was expanded to include control of both spring (nuisance) and summer mosquitoes (potential arbovirus vectors) in the genera *Aedes, Culex* and *Culiseta*. Each municipality adopted the general approach to meet local requirements as permanent breeding sites for *Culex pipiens* and *Cx. restuans* Theobald were included in the treatment program (MacKenzie 1975, 1976,[4,5]).

This report documents monitoring activities of pesticide applications that were established to allay public concerns about unnecessary and/or excessive use of larvicides.

METHODS AND MATERIALS

Between 1974 and 1980 the efficacy of temephos (*0,0,0′,0′*-tetramethyl *0,0′*-thiodi-*p*-phenylene phosphorothioate) was monitored in 12 mosquito abatement programs at 5 locations in Ontario (Table 1, Fig. 1). Four of these municipalities contained mosquito breeding habitats of less than 10 ha and control programs involved ground larviciding. The other location encompassed over 1000 ha and involved aerial treatment by helicopter. Target species were

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[5] MacKenzie, D., 1976. Municipal abatement programs. Pesticide Control Section, Ontario Ministry of the Environment, Toronto.

Table 1. Details on ground and aerial mosquito abatement programs for spring *Aedes* species in Ontario, 1974–80.

Location	Year	Area treated (ha)	Temphos rate a.i. (g/ha)	Temphos formulation[1]	Date of application	Mosquito larval counts/dip Sites	Mean	Range
(A) Ground Operation								
Orillia	1974	86	90	2G 4EC	May 1–14	4	55	30–100
	1975	38	67	2G, 4EC	May 6–24	5	30	5–110
	1976	53	90	2G, 4EC	Apr. 15–May 13	5	50	30–100
London	1975	17.5	75	2G, 4EC	May 8–21	1	75	50–100
	1977		90	4EC	July 5–14	3	100	70–130
Wallaceburg	1975	2.5	110	2G	May 3	3	110	75–200
Windsor	1976	80	90	2G, 4EC	Apr. 16–May 3	3	110	50–200
(B) Aerial Operations[2]								
Mara Township	1975	1730	70	2G	May 14–17	5	54	10–170
	1976	1340	90	2G	Apr. 20–May 1	7	54	25–200
	1977	1320	90	2G	May 4–8	4	15	1–30
	1979	1450	90	2G	May 2–10	45	30	0–60
	1980	1770	90	2G	May 2–4	23	50	0–100

[1] Granular (2G—2%) temephos was applied with a rotary spreader. Emulsifiable concentrate (4EC—43%) temephos was applied by manual 4–5 gallon back-pack sprayers or motorized back-pack mister.

[2] Aerial operations were carried out by helicopter backed up by the use of ground equipment to cover difficult-to-treat areas.

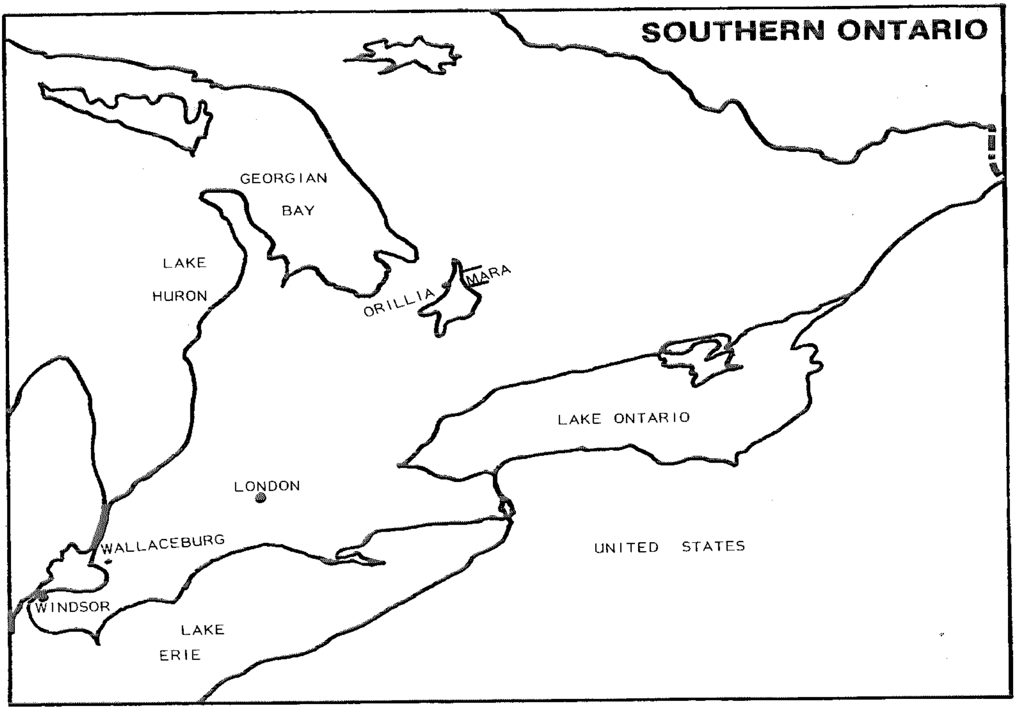

Fig. 1. Map of Southern Ontario showing cities and townships where mosquito abatement programs were conducted, 1974–80.

identified and treatment was commenced when larval counts reached 25 to 30 per 0.57 liter dip. Each potential breeding site was sampled by 0.5-1 dip/m^2 of surface area at various locations around the periphery to determine the average number of larvae per dip. Treatments were timed to coincide with early instar development of the majority of larvae. In reality, treatments in 1976 and 1977 were frequently made to pools containing fourth instar larvae. Both 2% granular (G) and 43% emulsifiable concentrate (E.C.) formations were used at registered rates of 2.8 to 5.6 kg of granular per ha or 24 ml of product E.C. per ha.

Emphasis was placed on monitoring larval survival in treated pools and assessing residue persistence of temephos applied to snow melt *Aedes* breeding habitat. Residue samples from representative breeding sites of water and sediment were collected in duplicate or triplicate immediately before pretreatment and at defined intervals following treatment. Pretreatment larval and pupal counts were compared with repeat counts 24–48 hours post-treatment at all sites, as a measure of program effectiveness.

GROUND OPERATIONS

Orillia—In 1974 potential breeding areas in the town of Orillia were mapped on a grid and these were updated following snow melt in each treatment year. A total of 282 ha of temporary surface water were mapped but only 86 ha had mosquito larvae in numbers requiring treatments in 1974, 38 ha in 1975 and 53 ha in 1976. Larval counts and species identifications were made on or around 1 May (Table 2). Temephos was applied mostly as a granular formulation by rotary spreader but also as emulsifiable concentrate by mist sprayer to breeding sites containing second to fourth instar (Table 1).

In 1975, four pools were selected for study, two were located in a wooded area, one in an open field, and the last in partial shade. Application of granular insecticide was made to open swampy grassland pools while the E.C. formulation was misted onto pools in heavily wooded areas. Painted stakes and later geologist's marking tape were tagged to bushes peripheral to treated pools as a marker to identify treated water.

London—In 1975, maps of potential breeding areas were prepared by the City Engineer and included permanent and temporary ponds, pools, swamps and ditches. By mid-April snow melt pools contained large numbers of identifiable larvae (Table 2). From 8 to 21 May, 10 ha of surface water were treated with the E.C. formulation of temephos and 7.5 ha were treated with granular temephos (Table 1). A motorized back-pack mist sprayer was used for liquid application. Most of the sites were between 0.1 and 0.2 ha. A pool in a semi-shaded wooded area treated 21 May was used to monitor temephos residues.

Existing maps of breeding areas were updated in 1977 to include the summer *Aedes* and *Culex* species during early July (Table 2). On 5 July treatment for summer mosquitoes commenced using temephos (Abate 4E) from motorized back-sprayers; three pools were sampled in triplicate for insecticide residue analyses.

Wallaceburg—Breeding sites within a 16 ha woodlot were mapped. On 3 May, 2.5 ha of

Table 2. Major spring *Aedes* mosquitoes identified from municipal abatement programs.

Aedes mosquito species	Treatment sites and year											
	Orilla			London		Wallaceburg	Windsor	Mara Township				
	1974	1975	1976	1975	1977	1975	1976	1975	1976	1977	1979	1980
Ae. barri											X	X
Ae. canadensis		X	X	X		X			X	X	X	X
Ae. cinerus	X	X	X	X			X	X	X			
Ae. communis								X	X		X	X
Ae. dorsalis											X	X
Ae. excrucians	X	X	X									
Ae. fitchii	X	X	X			X		X	X	X	X	X
Ae. implacatus						X		X	X			
Ae. intrudens								X		X	X	X
Ae. punctor	X		X									
Ae. sticticus		X	X	X		X						
Ae. stimulans	X	X	X	X		X	X	X	X	X	X	X
Ae. trichurus	X		X				X					
Ae. triseratus					X							
Ae. trivittatus					X							
Ae. vexans			X		X		X			X	X	X

water surface in woodlots were treated with temephos (Table 1). Three pools were monitored for larval survival and insecticide residues. On 5 May, a few pools were retreated where live larvae had been missed.

Windsor—Potential breeding sites were mapped before mid-March 1976. Temephos was applied by manual and motorized back-pack sprayers to 52 ha of water surface in woodlot areas. The granular formulation was applied by spreader to open grassland areas and ditches. Three sites with spring *Aedes* mosquitoes were selected in May for sampling of water and sediment for larvicide residues.

AERIAL OPERATIONS

Mara Township—Maps from earlier mosquito abatement programs were brought up to date by 5 May 1975, when larvae were identified and counts were found to be between zero and 50 per dip (Table 2). A helicopter applied granular temephos to 1060 ha of surface waters. Air blast equipment was used to aid spreading granules in a 30 m swath while flying 15 m above open water and 6 m above forest vegetation at a speed of 80 km/h. The remaining 670 ha were treated by ground spreaders (cyclone seeders). Four sites were selected within the aerially treated area for determining temephos residues.

Between 1976 and 1980 breeding areas were first visited between 30 March and 26 April. By mid-April, larvae were numerous and some had reached the fourth instar. Larval counts were made at both pre- and post-treatment times and larvae were identified (Table 2). Samples of water and sediment were collected for residue analysis from various sites: 7 (1976), 4 (1977), 14 (1979) and 23 (1980) as slight changes in formulation, rate, application timing and target sites occurred over the successive years.

SAMPLE COLLECTION. One-liter samples of water were collected from the treated sites and delivered to the laboratory for analysis within 48 hr. Approximately one kg of sediment was collected with either a standard brass 15 cm^2 Eckman dredge which sampled the top 3 cm or an empty metal (0.5 kg) can that was used to core approximately 6 cm with a trowel.

A variable number of random dips of water were made using a standard 0.57 liter white enamelled dipper to determine density of larvae and stage of development prior to treatment. A small mesh cylindrical trap with cones at either end was used to trap larvae over a 24 hr period for species identification. Table 2 lists the major *Aedes* species found at each municipality, at the time of treatment. Posttreatment counts were made on surviving larvae.

ANALYTICAL PROCEDURE

EXTRACTION. Water samples (1 liter) were accurately measured and transferred to a separatory funnel and partitioned twice by shaking for 1 min. with 100 ml portions of dichloromethane. The phases were allowed to separate and the dichloromethane extracts were drawn off and dried by percolation through anhydrous sodium sulfate and evaporated just to dryness with rotary vacuum at 50°C. The residues were then redissolved in a measured amount of acetone to give a 500 fold concentration factor. Further cleanup of the water extracts was not necessary for determination of temephos either by gas liquid chromatography (GLC) or high pressure liquid chromatography (HPLC).

Sediments (25 g) were extracted by shaking with 250 ml of a mixture of acetone: dichloromethane (1:1) for 2 hr. The extract was quantitatively filtered, transferred to a separatory funnel, diluted with 600 ml of a 2% sodium chloride solution and shaken for 1 min. The dichloromethane phase was drawn off and dried by passage through anhydrous sodium sulfate and evaporated just to dryness with rotary vacuum at 50°C. Residues were analyzed for GLC after redissolving in 5 ml of acetone.

For analysis by HPLC the sediment extracts were quantitatively transferred to a 15 mm i.d. chromotography column containing 15 g Florisil (60—100 mesh), and eluted with 75 ml of an acetonitrile: dichloromethane (1:4) mixture. The eluate was evaporated just to dryness and redissolved in 5 ml of acetonitrile.

DETERMINATION. In 1974, 1975 and 1977 analyses for temephos were performed by GLC equipped with a flame photometric detector in the phosphorus mode and set up with the following parameters:

Column:	50 cm × 2 mm i.d. packed with 3% OV-1 on 100/120 mesh Gas Chrom Q; column temperature: 225°C isothermal; Carrier gas: nitrogen at 60 ml/min.

In 1976, 1979 and 1980 determinations were made by HPLC set up with the following parameters:

Column:	30 cm × 4 mm i.d. C-18 μ-Bondapack
Mobile phase:	Acetonitrile: water (55:45) at an isocratic delivery rate of 3 ml/min.
Detection:	absorbance at 254 nm

RECOVERY AND DETECTION LIMITS. Recoveries were determined at fortification levels ranging from 5 to 100 μg/liter in water and 5 to 100 μg/kg in sediments. Recoveries of temephos as determined by GLC ranged from 74% to 119% for both sediments and water. By means of the HPLC determinative procedure, a recovery range of 86% to 97% was obtained for temephos, temephos sulfoxide and temephos sulfone.

Detection limits for temephos, based upon the sample sizes as outlined in this procedure, approximated 1 μg/liter for water and 10 μg/kg for sediments.

RESULTS

GROUND OPERATIONS

Orillia—In 1974, 86 ha of temporary surface water averaged 55 spring *Aedes* larvae per dip (Table 1). Larval counts posttreatment indicated that spring species were reduced 95% by the 90 g/ha application of temephos. On the day of treatment (May 1), mean residues of temephos in water were 0.8 μg/liter and in sediment 22 μg/kg. By day 4, residues had declined below the detection limits in both water and sediment (Table 3).

As *Mansonia perturbans* (Walker) is a serious nuisance factor in some cattail bogs, a preliminary study on granular temephos in a small cattail swamp was conducted. Cattails collected 1 hr after treatment with temephos contained residues of 20 μg/kg on a whole plant fresh weight basis. Four days later, residues on the plants were below the 10 μg/kg detection limit. No conclusion could be reached on the biocidal significance of these residue levels to *Mansonia*.

In 1975, pretreatment sampling pools on 1 May revealed 75–110 larvae per dip in the first to third instars in open areas and 8–15 larvae per dip in the first and second instar in woodland pools. Water temperatures at the time ranged from 10° to 11.5°C in woodland pools and 19° to 28°C in partial shade and open areas. Warm weather in late April and early May prompted rapid larval development and by the time treatments were commenced on 6 May, 30% of the larvae had pupated (Tables 1 and 3). Residues of temephos measured within the first hour following treatment averaged 8.1 μg/liter in water and over the next 48 hr residues declined to a quarter of initial values. Temephos levels in sediment increased over the first 24 hr but thereafter declined.

In 1976, prior to treatment, larval counts were high by mid-April and present in the second to fourth instars (Table 1). Eight days posttreatment larval counts were reduced to zero and no pupae were evident (Table 3). Water temperatures during this period were between 12° and 18°C and temephos residues in water declined below the detection limit (1.0 μg/liter) by day 2, but accumulated in sediment to 540 μg/kg. All residues disappeared by day 8. On day 2 the temephos residues in sediment were made up of 28% parent compound, 35% sulfone metabolite and 37% sulfoxide metabolite.

London—Snow melt pools monitored for larvae in mid- to late April 1975, had an average of 75 larvae per dip in the second and third instars. Following application (May 21), temephos declined rapidly in water from 16 to 1.0 μg/liter in the first 24 hr (Table 3).

In 1977 pools were monitored for summer *Aedes* species in early July and large numbers of all instars were found (100 larvae per dip); *Cx pipiens* was also identified (Table 2). Pupae were also found. Posttreatment assessment of effectiveness revealed no surviving larvae. Following treatment July 5, residues of temephos in water declined rapidly over the first 24 hr while residues in sediments increased to a maximum (180 μg/kg) over the first 3 days and thereafter declined (Table 3).

Wallaceburg—On 22 April 1975 pools were found to contain large numbers of larvae. By 1 May these pools were producing 100 larvae per dip just prior to treatment with 100 g/ha of temephos on 3 May (Table 1). Species identification appears in Table 2. Within 48 hr larval mortality was 100%. Residues in water declined from 8.7 to 1.3 μg/liter in 48 hr (Table 3). Only low residues (100 μg/kg) were found in sediment.

Windsor—Mosquito larvae were first discovered on 19 March 1976 in breeding areas within the city limits. By 5 April, larvae were found in almost every woodlot, and by mid-April, larvae were numerous throughout the breeding areas in the city. The main species were identified and appear in Table 2. Following the application of temephos (May 7) no larvae were found to have survived. Residues in water declined from 19 to 2 μg/liter in the first 72 hr (Table 3). Very high residues found in sediment suggested that the rate of application had been in excess of that intended. Residues recovered from sediments were present almost entirely as the sulfone while those found in the first hour in water were predominantly the parent compound temephos (66%) with lesser quantities of the sulfone (21%) and sulfoxide (13%) metabolites being present.

AERIAL OPERATIONS

Mara Township—Larval counts made prior to treatment on 5 May ranged from zero to 50 per dip. By 12 May, numbers had risen to between 10 and 170 larvae per dip. Counts, made a few days posttreatment with temephos, revealed

Table 3. Posttreatment larval counts and residues of temephos in water and sediment from ground application 1974–80.

		Posttreatment 24–48 hr larvae counts/dips						Temephos residue[1]			
								Water (μg/L)		Dried Sediment (μg/kg)	
Location	Year	Sites	Mean	Range	Pupal counts Range	Time	Samples	Mean	SD	Mean	SD
Orillia	1974	3	1	0–5	Present, not	1 hr	3	0.8	0.6	22	3
	(May 1)				counted	4 days	3	<0.5	—	<10	—
	1975	4	10	1–30	10–50	1 hr	4	8.1	2.2	250	240
	(May 6)					24 hr	4	4.0	2.1	525	900
						48 hr	4	1.8	1.5	125	50
	1976	5	0	0	0	1 hr	4	1.0	1.0	<10	—
	(Apr. 21)					48 hr	4	<1.0	—	540	430
						8 days	4	<1.0	—	<10	—
London	1975	1	0	0	50	1 hr	1	16		10	
	(May 21)					24 hr	1	1.0		100	
						6 days	1	<1.0		<10	
	1977	3	0	0	Present	0 hr	3	220	178	12	5
	(July 5)					8 hr	3	11.1	8.8	—	
						24 hr	3	8.6	10.7	180	52
						2 days	3	1.0	1.0	—	
						3 days	3	<1.0	—	90	125
						5 days	3	<1.0	—	30	30
Wallaceburg	1975	3	0	0	0	1 hr	3	8.7	5.0	<10	—
	(May 3)					24 hr	3	2.3	1.5	100	50
						48 hr	3	1.3	0.6	<10	—
						7 days	3	<1.0	—	<10	—
Windsor	1976	3	0	0	0	0 hr	3	19	7.7	1350	1430
	(May 7)					1 hr	3	16	7.0	4710	7180
						24 hr	3	6.0	5.1	11110	18100
						48 hr	3	5.3	2.0	8250	10900
						72 hr	3	2.0	1.0	7850	10120

[1] Includes parent compound plus sulfone and sulfoxide metabolites.

larvae had been killed at most sites, however, 0 to 18 pupae per dip were found (Table 4). A few pools had live larvae with up to 50 per dip, where 150 to 170 larvae, just prior to treatment, had been counted (Table 1). These larvae survived in spite of granules visibly present in the pools. Residues of temephos declined slowly in the water from 6 to 2 μg/liter in 14 days. High residues were found in sediment at day 14.

In 1976 mosquito larvae hatched earlier than in 1975. Just prior to treatment with temephos, larval counts ranged from 25 to 200 per dip at 7 sites (Table 1). Most of the larvae were in the second and third instars. Temperatures of water in the woodland pools ranged from 11.5° to 13.5°C. Four to six days following treatment with temephos, larval counts were zero. Residues in water 4 hr after the insecticide was applied averaged 4 μg/liter and declined to 1 μg/liter after 24 hr (Table 4). Residues in sediments peaked at 9200 μg/kg 24 hr after treatment and declined to 280 μg/kg on day 10. The parent compound, temephos, was present as 35 to 37% of the residue in sediment for the first 6 days after treatment, but declined to 21% of the residue by day 10. The sulfoxide metabolite was present as 34 to 61% of the total residue between day 1 and day 10. The sulfone metabolite increased from 7 to 31% of the residue over the same 10 day period.

By May 1977, many of the spring *Aedes* breeding sites were reduced in size as compared to earlier years, through an active public works program of ditching and draining. Only low numbers of larvae were found in pools, however, because of advanced development, treatment started by 4 May (Table 1). While the kill of larvae was almost 100%, many larvae had pupated by the time temephos applications were made (Table 2). The 1979 and 1980 spring seasons were late and larval development was slow, however, more species were identified than in previous years (Table 2) and included *Culiseta inornata* (Williston).

On 1 May 1979, with water temperatures ranging from 5° to 15°C, larval counts ranged from 0 to 60 per dip and were present in all four instars. Following the application of temephos, no live larvae could be found in all but a few of the 45 sites checked. Residues of temephos in water were below the detection limit (1.0 μg/liter) one hr after treatment. Residues in sediment were present over the first nine days, but declined to less than the detection limits by day 12 (Table 4).

Between 26 April to 1 May, 1980, larvae were monitored in possible breeding areas. Numbers collected at 23 sites ranged from zero to 100 larvae per dip (Table 1). Aerial treatment commenced 1 May and was completed in 3

Table 4. Posttreatment larval counts and residue of temephos in water and sediment from aerial application 1975–80 (Mara Township).

		24–48 hrs Posttreatment					Temephos residues[1]			
		Larval counts		Pupal count			Water (μg/L)		Sediment (μg/kg)	
Year	Sites	Mean	Range	Range	Time	Samples	Mean	SD	Mean	SD
1975	8	14	0–50	0–18	3.5 hr	3	6.0	1.0	<10	—
					24 hr	3	2.0	1.0	NA[2]	—
					14 days	3	2.0	2.0	1715	3227
1976	7	<1	0–2	0	4 hr	1	4.0	—	2900	—
					24 hr	3	1.0	1.0	9200	5374
					4 days	4	1.0	1.0	1852	1444
					6 days	3	1.0	1.0	1696	1332
					10 days	3	<1.0	—	280	216
1977	4	0	0	0–20	1 hr	4	22	36	292	416
					24 hr	4	1.7	1.3	340	574
					60 hr	4	1.0	1.0	353	510
					5.5 days	4	1.5	0.6	1545	515
1979	14	<1	0–4	0	1 hr	13	<1.0	—	450	163
					4 days	3	<1.0	—	NA	
					9 days	3	<1.0	—	550	
					12 days	3	<1.0	—	<10	
1980	23	0	0	0	1 hr	9	3.9	3.8	NA	
					24 hr	9	2.3	1.0	NA	
					48 hr	4	<1.0	—	NA	

[1] Includes parent compound plus sulfone and sulfoxide metabolites.
[2] NA—not analysed.

days. Water temperatures were between 9° to 15°C just prior to treatment but rose to 17° to 28°C 24 hr posttreatment and then declined to between 11° and 17°C 48 hr after treatment. No pupae were found in the monitored sites. Residues of temephos declined over 48 hr from 3.9 to 1.0 μg/liter (Table 2). In the first hour the temephos residue in water consisted of 75% parent material, 16% sulfoxide and 9% sulfone metabolites. After 24 hr the respective percentages were 51, 41 and 8.

DISCUSSION

Many previous workers have shown temephos to be an effective larvicide for mosquitoes (McDuffie and Weidhaas 1965, Bowman and Orloski 1966, Bang and Tonn 1969, Barnes and Webb 1968, Mulla et al. 1969, Novak 1972, Schober 1967); this efficiency has also been demonstrated in the 12 abatement programs carried out at five locations across Ontario. Residues of temephos degraded rapidly in water, supporting the findings of Bowman and Orloski (1966).

In our study, peak concentrations of temephos in water during early May occurred within one hr of treatment of the 4 E.C. formulation (mean approx. 20 μg/liter) and within 8 hours of treatment with the 2G formulation (mean approx. 9 μg/liter). The rate of degradation in water appeared to be affected by the initial solubility of the temephos which is itself influenced by the application site, the water temperature and the formulation applied. Our findings support a general half life disappearance of 24 hr for the active ingredient under conditions found in local spring *Aedes* breeding habitat.

Determining trends of the breakdown of temephos in sediment residues appeared more complex since sediment samples, particularly in Mara Township, were difficult to collect using the prescribed standard techniques of utilizing an Eckman dredge. In 1976 mechanical disintegration of the granular formulation in the helicopter hopper and blower auger system resulted in a large amount of powder being deposited on the ground. In 1977, therefore, a more compact and smaller mesh sized granular was used for the temephos formulation. These changes were reflected in the highly variable residue concentrations in sediments reported in Table 4 for Mara Township.

The residue levels found in sediments from Windsor in 1976 and appearing in Table 4 are abnormally high because these pools were treated twice. The first application in late April was without effect on the larval population. A drop in water temperature from a freak freeze at this time was accredited with having a negative effect on larval feeding and metabolism and thus the absence of a larvicidal effect. Therefore, the three sites in Windsor monitored on May 7 reflect a 'worst possible case' situation where higher than recommended rates were used to ensure larval kill; accurate records of the retreatment sites were not kept.

Eliminating the above explained variations in sediment analyses, the mean peak concentrations of temephos residues in sediments were in the 250–500 μg/kg range following a single early spring application of 90–100 g/ha and declined to negligible levels in 10 days.

Larval mortality of spring *Aedes* mosquitoes appears to be a direct result of temephos levels in water and not those in sediment. As temephos residue levels in water declined rapidly in the first 24 hr post-treatment period, the standard practice followed by municipalities of assessing the total larval mortality at 24 hr posttreatment would appear to be a scientifically valid one.

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