ORGANIC PHOSPHATES FOR CONTROL OF *CULEX PIPIENS MOLESTUS* MOSQUITOES NEAR JERUSALEM, ISRAEL

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INTRODUCTION. Most of the trials were carried out at Wadi Malcha. This wadi which begins near Jerusalem, carries away rain falling along the Israel-Jordan border, a distance of over 30 kms. as far as Wadi Sarrar. As the rainy season is of short duration, extending from the middle of November until the middle of March, Wadi Malcha would normally dry up in April, as is the case with other similar wadies in Israel. However, the use of the wadi for the disposal of the city sewage at the rate of 10,000–12,000 cubic metres per 24 hours, has made it a permanent stream. The water for the greater part of the year flows along a distance of about 24 kms. along a zig-zag bed of gravel. The wadi is rich in vegetation, dropping from an elevation of 820 metres to 620 metres above sea level.

The bed of the wadi varies from a narrow channel with swift flowing water to large ponds or branched sections where the flow is very slow, giving rise to swamp-like areas up to 30 metres in width. Along the entire length of the wadi and especially in the swampy areas, there is always heavy breeding of *Culex pipiens molestus,* and the rich vegetation shelters large numbers of adults.

The mosquitoes developing in the wadi present a great nuisance problem to the residents of the various settlements situated on both sides of the wadi, including the town of Jerusalem itself up to a distance of 2–4 kms.

On Chamsin (hot dry winds) nights and in the autumn, the dispersal of the mosquitoes is even greater.

All non-chemical methods of treating the wadi are ineffective, because the sewage and the rainfall soon restore the situation to its former state and the growth of the vegetation is rapid.

There is no possibility of reaching the breeding sites by mechanical transport, because the narrow wadi passes through steep hills where there are no paths or roads.

Approach for the purpose of chemical application is possible only by donkeys and experience has shown that chemical treatment along the length of the wadi is extremely difficult. Solar-oil, 0.8 percent dieldrin in malariol, malariol plus DDT (1%) and Baytex were among the materials used in experiments. Because the wadi contains only sewage water flowing at a distance from residential areas so that man and animals do not come into contact with this water, and as all other methods of *Culex* control proved expensive and unsatisfactory, it was decided to try to control the mosquitoes in this wadi by the use of organic phosphates, applied by a new and cheaper method.

CONTROL EXPERIMENTS BY MEANS OF A PARATHION DRIP. The first observation was made on June 27, 1958 over a stretch of 4 kms., where the stream flow was at the rate of 80 cubic metres per hour. At the beginning of this stretch, a 200-litre drum filled with water and parathion emulsion and fitted with a dropper was placed at the side of the stream and the drip was regulated to yield two litres of the liquid per hour, equivalent to 0.1 ppm. of parathion in the stream.

Examinations carried out after 24 and 48 hours showed that all larval stages near the drum were dead, but that pupae were unaffected. With increase in distance from the drum, mortality in the third and fourth stage larvae declined.

After 96 hours no live larvae were found along the entire stretch, but between the third and fifth kilometres, a few pupae were collected. Under laboratory condi-

tions, they developed and the mosquitoes survived.

The second observation was carried out on July 10, 1959, following application of the same method described above, but using higher concentrations during a shorter period over a longer stretch. This time two drums were employed at a distance of 5 kms. apart and over a stretch of 10 kms. The drips were adjusted to give 0.4 ppm. of parathion in the stream. After 48 hours no breeding was found along the entire 10 kilometre stretch.

The third observation was carried out on June 15, 1960. On this date breeding was extremely heavy and adults were abundant in the vegetation and in sheltered spots. A drum was located so as to cover a stretch of 3 kilometres where breeding was most dense. The drip at the rate of 2 litres per hour of 47 percent parathion in 200 litres of water gave a final dilution of 0.3 ppm. in the stream. After 96 hours, all larvae were dead, pupae had disappeared and large numbers of adults were found dead on the water. Twenty-four hours after the drip had ceased, 1st stage larvae were found close to the drum and at the end of the 3-km. stretch.

The above three observations show:

1. Larvae of all stages can be destroyed during a period of 48–96 hours by parathion drip giving a final solution of 0.1–0.4 ppm.
2. Eggs and pupae are almost unaffected by parathion.
3. Twenty-four hours after the drip has ceased, eggs may hatch and the 1st stage larvae begin to develop.
4. Many adults die on the surface of the treated water.

It seems clear that the use of parathion by the drip method over a period of 48 hours with a pause of 5–7 days between applications, can give successful control of *Culex pipiens molestus*.

Additional observations were carried out along a 10 kilometre stretch 14 days after the last application of the parathion drip from one drum at the rate of 0.2 ppm.

The aim of these observations was to see the gradation in the killing action of parathion along the stream.

The results were as follows:

Length of Stretch	*After 36 hours*	*After 72 hours*
1st 3 klms.	Free of larvae	Free of larvae except for first stage at head
2nd 3 klms.	Pupae only	of wadi
Next 2 klms.	3rd and 4th stage larvae and pupae	All stages and pupae except 1st stage larvae
Last 2 klms.	2nd and 3rd stage larvae	Breeding of all stages

CONTROL OF THE ENTIRE WADI MALCH (ABOUT 22 KLMS.) BY MALATHION SPRAY AND PARATHION DRIP. In 1962, when the *Culex* mosquito nuisance in this area was particularly severe, it was decided to treat the whole wadi by organic phosphate insecticides. In this year people came in contact with the upper reaches of the wadi and even used the water for irrigation. For this reason, it was decided to treat this stretch of the wadi (10 klms.) by spraying twice a month with 2.5 percent malathion emulsion. The cost of each application was as follows:

1) 25 kgs. of 50 percent malathion	IL	90.–
2) 500 kg " " Malariol		60.–
3) 18 workdays		200.–
4) Transport		120.–
	IL	470.– ($156.6

On the lower stretches of the wadi parathion drip was applied by means of three drums separated by a distance of 5 klms. Details of this application, which was carried out on 8-VII, 15-VII, 22-VII and 31-VII are as follows:—

METHODS OF PARATHION DRIP APPLICATION. The concentrated material (47 percent emulsion) was introduced into three drums, each containing 200 litres of water and released by drip. The distance between the first and second drum was 5 kilometres and between the second and third drum 5 kilometres. Altogether 1

itres of the concentrate were used, as ollows:—

In the first drum 5 litres (1.2 percent oncentrate);

In the second drum, 4 litres (1.0 percent oncentrate) and in the third drum, 3 itres (0.75 percent concentrate).

In order to prevent blocking of the ozzle, the opening was enlarged so that litres of the solution were released per our. This means that from the first drum o grms. of the concentrate were released er hour into 350 cubic metres of water, iving a final solution of 0.2 ppm., and rom the other two drums less material vas released, but the stream already conained some of the insecticide released rom the other drums, higher up the vadi.

DETAILS OF THE APPLICATION

1. Insertion of the dripper into the drum and measurement of amount released. A stem and nozzle taken from an ordinary pressure sprayer was modified for this purpose.
2. The sewage water from the stream was used in the drums because of the difficulty of bringing fresh water from far away and because of the labour and transport costs involved.

   The water was filtered through three sieves, the first having a mesh of 1.5 m/m, the second 1 m/m and the third 0.2 m/m.
3. The drum, lying on its side, was half filled with water. The parathion was carefully poured into the drum. After rocking the drum to and fro for a few moments, it was filled with water and closed hermetically.
4. The dripper was set in action with the tap wide open.

RESULTS

(I) *After First Application*

(a) *After 48 hours:*

Larvae — all dead
Pupae — many survivors

(b) *After 96 hours:*

Larvae — appearance of 1st stage
Pupae — disappeared

(c) *After 6 days:*

Larvae — all stages present but at a density of about 10 percent of the pre-treatment population
Pupae — None found
Adults — Many dead seen on the water

(II) *After Additional Applications*

The progressive diminishing of breeding was noted from application to application and after the third application all breeding and all adults disappeared completely.

Observations carried out two weeks after the fourth and last application showed the presence of breeding, including pupae, and some adults were found in the vegetation.

PRECAUTIONS

(a) Overalls, rubber gloves and aspirators were worn by the workers.
(b) During working hours the workers neither ate nor smoked.
(c) The work was carried out under the supervision of the anti-malaria inspector (D.P.) who had passed a special course and who is licensed to work with parathion.
(d) The drum was hidden by dense vegetation providing camouflage, and near the drums were placed warning signs bearing the words: "Poison, Danger, Do not touch!"
(e) Immediately after work, the gloves were washed in soapy water. The workers bathed in water and soap, changed their clothes and the used clothes were sent to the laundry.

COSTS OF EACH APPLICATION

1. Parathion—12 litres at IL.5.– per litre	IL 60.–
Two workdays at IL.12.50 per day	25.–
Transport	20.–
	IL 105.– ($35.00)

2. Each spraying of the parathion-treated stretches with 2.5% malathion in Malariol would cost:

Malathion—75 litres at IL.3.50 per litre	IL 262.50
Malariol—1½ tons	160.–
30 workdays at IL.12.50 per day	375.–
Transport	200.–
	IL 997.50 ($332.50)

The ten-fold increase in cost of the malathion spray would not give results equal to those obtained with the much cheaper parathion drip application, the difficult terrain and dense vegetation making spraying from the ground ineffective.

The drip method has shown itself to be the cheapest, simplest and most effective under these conditions. No technical operations such as clearing vegetation, digging of channels, alteration of stream flow etc., are necessary. It should be emphasized that such applications are only practicable in situations where man and animals are unlikely to make contact with the water.

Further trials will be carried out in order to establish the minimum dilution of parathion necessary to obtain similar results.

CONCLUSIONS. The above observations show that:

1. Parathion is highly effective for the control of *Culex pipiens molestus*.
2. The activity of the material in sewage water is of very limited duration.
3. The method of applying the drip for five days continuously followed by a rest of five days is not satisfactory because:
   (a) The concentration of the same amount of parathion over a period of five days is much smaller than during one or two days.
   (b) The nozzle opening for a prolonged application is smaller and therefore is liable to become easily blocked. Because of difficulty of approach for daily inspection, the drip may cease altogether.

It is therefore much more effective to release larger quantities over a period of one or two days with a pause between applications based on the development period of the larvae up to the pupal stage (about 7 days in the Israel summer).

SUMMARY

1. A successful method of controllin *Culex pipiens molestus* breeding in sewage stream of more than 20 klm in length, is described.
2. The method consists partially spraying 2.5 percent malathion i Malariol, twice monthly, with lin ited effect, and partially by a weekl drip of parathion, 0.1–0.4 ppm. wit excellent results against larvae of a stages.
3. It was observed that the parathio applied as a larvicide also caused high mortality in adult mosquitoes i the vicinity.
4. The last observations show that parathion drip from one drum at th rate of 0.2 ppm. is not sufficient act satisfactorily along a stretch 10 kilometres. The reasons may l degradation of the parathion in th sewage or the low final dilution the insecticide.