NOTES ON THE CHEMICAL CONTROL OF ADULT MOSQUITOES

BY
ANDREW BLAIR

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1. INTRODUCTION

There is now growing acceptance of the importance of wetlands to the environment of the Swan Coastal Plain. As well as providing habitats for water birds, estuaries, rivers, lakes and swamps are highly productive in terms of plant and animal life; and they have great scenic and recreational value. Less well understood is the capacity of wetlands to cleanse polluted waters of contaminants. In the local environment our lakes and swamps are surface expressions of the groundwater, thus the state of the lakes and swamps will reflect the condition of this enormously important resource.

An unfortunate consequence of the existence of expanses of water is that many insect pests, particularly dipterans such as mosquitoes and midges, have aquatic larvae. Therefore the retention of lakes and swamps,as an important part of the landscape, can increase the occurrence of these pests in nearby residential areas.

Mosquito breeding in rivers, lakes and swamps is often promoted by degraded conditions, such as damage to fringing vegetation, trampling of foreshore areas to produce stagnant pools and fouling of wetland fringes by litter and stock. Some species of mosquito thrive best in stagnant polluted water. Some prefer water bodies which have low levels of dissolved oxygen such as eutrophic waters, while others breed in more pristine conditions. Two species which occur locally are adapted to breed in tidal waters. In many cases conditions suitable for prolific insect breeding can be controlled by careful management without chemical intervention. It should be everyone's aim to achieve such a state of affairs.

In some cases, however, emergencies arise when mosquitoes reach plague numbers and cause distress to householders near wetlands. Such occurrences require urgent procedures, usually chemical control. If chemicals are to be used it is important that the chemical and the method of application be chosen with care so as to protect the environment as much as possible.

In presenting the following two experiments relating to control measures under local conditions it is hoped to stimulate discussion on the various methods of control. These two experiments made use of the insecticide naled, which is currently being used for mosquito control in the Perth Metropolitan area.

The first of the experiments was carried out in the Shire of Canning by senior zoology students from the University of Western Australia, supervised by Dr Winston Bailey.

The second experiment was carried out at Lake Joondalup, during a study jointly sponsored by the Shire of Wanneroo and Department of Conservation and Environment. The work was carried out by the investigator, and Wanneroo Shire personnel.

The aim of reporting these studies and notes on the chemical control of mosquitoes is three-fold. Initially it makes available local results to be viewed and judged by the people concerned with mosquito control. Secondly it may, hopefully, encourage organisations who use chemical control to monitor the effectiveness of their control programmes. The collection of such data will allow for more objective and well founded comparisons between methods. (comparison of economics, procedures and efficiencies.) Finally it is hoped to stimulate discussion of insect control by other than chemical means.

2. THE CHEMICAL - NALED (DIBROM 14)

DIBROM 14 is the registered trademark of the Chevron Chemical Company for the organophosphate insecticide commonly known as naled.

The structural formula of DIBROM 14 is:

1, 2 dibromo - 2, 2 - dichloroethyl dimethyl phosphate

DIBROM 14 is described as being a short residual chemical which decomposes by hydrolysis and biological degradation. Hydrolysis is decomposition by chemical reaction with water, while the factors contributing to biodegradation are: temperature, pH, moisture, microbes (found in the soil, water and air) and sulfhydro groups (-SH), (sulfhydro groups are chemical structures found virtually everywhere).

It is assumed that a combination of hydrolysis and biodegradation usually occurs in nature. Biological degradation occurs in either aquatic or terrestrial situations. It has been stated[1] that upon release most of the naled will be degraded within 24 hours, and that metabolism and tissue studies show that neither naled nor its metabolites are stored in the animal body.

3. CHEMICAL APPLICATION TECHNIQUES

3.1 Four Methods of Application

According to the manufacturers DIBROM 14 concentrate can be applied in four ways:

1. By aircraft, diluted in fuel or diesel oil to deliver 55 - 110 grams actual insecticide per hectare. (0.05 - 0.1 lb/ac).

2. By ultra low volume dispersal, with aircraft, at the rate of 35 - 75 millilitres of insecticide per hectare. (0.5 - 1 US fl oz/ac).

3. By thermal foggers, diluted in fuel or diesel oil at the rate of 7.8 litres of insecticide per kilolitre of oil (3.1 US qts/99 US gals).

4. By ground ultra low volume non-thermal application diluted in soya bean oil to deliver 22 grams actual insecticide per hectare (0.02 lb/ac).

The first two techniques require blanket aerial spraying and have been used only on a demonstration and experimental basis within the Perth area. These techniques have been developed for control in large, mostly impenetrable areas and are of little value in controlling mosquitoes breeding in small habitats within high density residential areas.

The second two techniques, that of thermal fogging and ULV application, have been used on an experimental basis and for ongoing control programmes, within the Perth Metropolitan region. It is with these two techniques that this bulletin is concerned.

3.2 High Volume and Ultra Low Volume Methods of Application

In 1968 Mount, Lofgren, Pierce and Husman[10] introduced the use of Ultra Low Volume (ULV) non-thermal aerosols applied with ground equipment. Prior to this, investigations had established that ULV aerial sprays of several insecticides would effectively control adult mosquitoes. It was seen that ULV application using ground equipment would have several advantages over high volume application:

1. it would eliminate, or reduce to a minimum, the need for carriers, solvents and additives;

2. it would reduce the amount of spray solution or mixture that has to be carried and applied;

3. it would eliminate mixing and diluting insecticides, and

4. it would permit a reduction in the size of the equipment.

Since that time, much work has been done on developing ULV cold aerosol application of insecticides and today the method is well accepted as an effective control procedure.

To illustrate the difference between ULV cold aerosol application and high volume thermal fog application, it is beneficial to include Table 1, taken from Mount, et al 1968. The table shows that the dosage rate per area can be the same for both techniques. The variables that are changed are the dilution factors and the flow rates.

Using ULV dispersal at an application rate of 0.036 pounds Malathion per acre, 95% Malathion (undiluted) is applied at a flow rate of 1.36 gallons per hour. However, at the same application rate, using high volume dispersal a mixture of 4% Malathion and 96% No. 2 fuel oil, is applied at a flow rate of 40 gallons per hour. With this illustration in mind, the advantages listed above (1 to 4) may be more obvious.

Fultz et al[4] in 1972 made comparison between high volume thermal aerosols and ULV non-thermal aerosols. The insecticide Malathion was used as the toxicant, In the experiments the thermal fogs were produced by propane fueled TIFA (Todd Insecticide Fog Applicator) units, while the cold aerosols (ULV) were produced from LECO (Lowndes Engineering Company) HD model generators. The efficiency with which each method controlled mosquitoes was measured in three ways:

(a) Number of complaints recorded over a specified time before and after respective treatments.

(b) Landing rate counts undertaken at specific sites, before and after respective treatments.

(c) Light trap data before and after treatments.

For further discussion on testing the efficiency of mosquito control procedures see Section 4.

Table 1 (taken from Table 2, Mount et al[10]) :

Comparison of ULV non-thermal and high volume aerosols of Malathion - shown to illustrate the differences between the two techniques.

Dose* (lb/acre)	Concentration (%)	Flow Rate (gal/hr.)
ULV - (95% malathion, undiluted)		
0.0045	95	0.17
0.009	95	0.68
0.018	95	0.68
0.036	95	1.36
High Volume - (malathion diluted in No. 2 fuel oil)		
0.0045	0.50	40
0.009	1	40
0.018	2	40
0.036	4	40

* Based on a 183 metre (600 ft) swath and a truck speed of 8 km/h (5 mph) except for the ULV dose of 10.21 kg per hectare (0.009 lb/acre) which was dispersed at 16 km/h (10 mph)

The conclusions of the comparison were as follows:

i) ULV non-thermal generators provided adult mosquito control equal to that experienced with thermal aerosols.

ii) The operating cost of thermal aerosols was higher than for non-thermal aerosols.

iii) The ULV non-thermal aerosol generators (because they are smaller units) mounted on compact vehicles provided superior accessibility in most areas.

iv) Visibility limitations, inherent in thermal aerosol generators (production of fog) were completely eliminated by using ULV generators.

v) Thermal aerosols offered marginal advantages over ULV aerosols in areas having extremely dense ground covers.

Such conclusions were reinforced by Rathburn and Boike (1972)[16]. Gorham (1974)[5] also reinforced the fact that thermal fogs of insecticides (in this case naled) penetrate dense brush barriers more effectively than do non-thermal fogs.

Of current concern in the local situation is the effect that the carriers, solvents and additives, (eg. Dieselene) required for high volume thermal fogging, may have on the vegetation with which they come in contact. Wetland flora, within mosquito control areas, is liable to regular exposure to the fog substance, which is often 97% dieselene.

ULV aerosols and high volume thermal aerosols are, generally regarded as adulticides. Lofgren (1970)[7] stated that ULV spraying works well against adult mosquitoes, but it is limited for larval breeding areas because vegetation reduces its effectiveness.

However, subsequent to this Coombes, Lee and Miesch (1973)[3] showed that ULV ground aerosol applications of certain insecticides (naled was not tested) will kill mosquito larvae contained in paper cups, placed in a natural control situation. They concluded that routine applications by mosquito workers against adult mosquitoes may also have an effect against the larvae.

3.3 Droplet Size - An Important Application Factor

An important result to emerge from the study of ULV application (and other techniques for that matter) is that droplet size of an aerosolised insecticide influences its efficiency in killing adult mosquitoes. Mount *et al* (1968)[10], Mount (1970)[9], Mount and Pierce (1972)[11] and Lofgren *et al* (1973)[8] indicate that, for maximum efficiency, insecticidal aerosols for ground dispersal should have droplets of about 10μ in volume median diameter ($\mu = 10^{-6}$m), with most of the volume in droplets of 5 to 20μ diameter. This relationship between droplet size and mosquito kill exists because the transport of droplets in the environment and impingement on mosquitoes are functions of size. Aside from reduced insecticidal efficiency, improper droplet size of aerosols could cause unnecesssary contamination of the environment. Moreover, manufacturers of insecticides have included droplet size requirements on their ground aerosol labels (Mount *et al* (1975)[12]). Similarly the onus is on the manufacturers of aerosol generating units to market equipment capable of producing droplet size specifications.

The techniques for assessing droplet sizes of insecticidal sprays and fogs are well developed. For further information see the references cited above ([8,9,10,11]).

3.4 Rate of Application of Insecticide

Application rate of aerosolized insecticides (quantity of undiluted insecticide per unit area), dispersed from vehicle mounted equipment, is calculated on the basis of effective swath width, vehicle speed and rate of flow of insecticide.

Effective swath width is the distance over which the insecticide particles spread, from the source, while still maintaining at least 90% mortality of caged insect pests, ie. 90% of insects held in cages are killed by the insecticide swath (this technique is described in Section 4). Ninety percent mortality for effective swath width is an arbitrary value but one which is commonly accepted by workers in this field (Husted *et al* (1975)[6]). A lower definitive mortality used to measure effective swath width is 85%.

It is reported (Mount *et al* (1970)[13]) that swath width is a function of insecticide dose (rate of flow of insecticide), droplet size and weather conditions.

Effective swath width under label recommendations and optimum conditions, is generally considered to be about 100m (a convenient metric conversion) and this distance is the basis on which application rates are calculated.

Vehicle speed obviously affects rate of application. At a set insecticide flow rate, the actual rate of application of insecticide can be altered by increasing or decreasing the speed of the vehicle.

A convenient vehicle speed for dispersing insecticides, and for calculating application rates (metric) is 10 km/hour. Pfuntner (1977)[14] reports that a combination of a vehicular tachometer and a common stop-watch constitutes a system with which pesticides can be applied more accurately and efficiently. The method described also provides a useful means of determining the size of the area treated, concurrent with the actual spraying operation.

3.5 Control Procedures

The time of application of aerosolized insecticides is very important for efficient and effective control of mosquitoes. It is important to maximize the chances of impingement of insecticide droplets on target organisims and this is best done in periods of maximum flight activity. Otherwise, mosquitoes will be harbouring within day-time resting places (eg. vegetation, cool positions in association with river banks, etc.), which restrict the distribution of insecticide and, hence, contact with the target insect.

As most mosquito species are crepuscular by nature (appearing or active in the twilight period), dusk is the most efficient control period.

To be balanced with this factor, is that of weather conditions. In principle, control should be undertaken during periods when conditions are optimum for the effective distribution and maintenance of the aerosol swath, ie. a gentle breeze to carry the aerosol without disruption of the swath, and temperature conditions to maintain the swath. In practice conditions are rarely optimum and compromise conditions, which decrease the effectiveness of the control procedure, are accepted.

Frequency of application is a further factor, important for efficient and effective control. Frequency of application of an insecticidal control is generally a function of the specific control situation, taking into account, size of control area, species of mosquito, breeding habitat, effectiveness of control and prevailing weather conditions.

3.6 Some Errors Inherent in ULV Operations

Several errors inherent in spraying operations are magnified as application rates become smaller per unit area (High Volume versus Ultra Low Volume).

Thompson (1973)[12] has reported on some of these errors, the most common of which result from faulty measurement of the pesticide during application.

As the volume of solution to be applied per unit area decreases, the percentage of the active agent in the spray solution necessarily becomes greater. The lesser the amount being applied per unit area, the greater becomes the probability of an error in measurement.

There are considerable difficulties involved in measuring the flow rate of a viscous liquid, whose temperature is changing. The flow rate does not vary as a smooth curve function.

Minor changes in air pressure at the atomizing nozzle of ULV generators may result in an ineffectual spray being generated.

Further, more complex, errors are listed within Thompson's paper.

4. EXPERIMENTAL TECHNIQUES FOR THE EVALUATION OF THE EFFECTIVENESS OF INSECTICIDAL CONTROL

In the development of such application techniques it has been important to determine the effectiveness of the techniques. For this purpose four methods are available:

1. Mortality of caged mosquitoes placed in the path of the insecticide swath.

2. Landing rate evaluations for mosquitoes before and after the control procedure, ie. the number of mosquitoes counted landing on the exposed skin of a pest control officer, per unit time.

3. Determination of the quantitative effects of the control procedure on mosquito breeding, ie. a change in the number of larvae and pupae per unit volume of breeding habitat.

4. Continuous monitoring of the mosquito population through trapping of adults before and after control.

Methods 1 and 2 above represent methods which give immediate results. However, methods 3 and 4 are used for more long-term assessment.

One of the more widely used techniques is that of mortality of caged mosquitoes, and it is this method that is used in these experiments. The basis of the method is to construct a transect of caged mosquitoes lying down wind and perpendicular to the course of the dispersal unit. The transect may be of any length and the cages are set at recorded heights above ground. Following the application of the insecticide, mortality counts per cage are taken with time. In this way the effectiveness of the insecticide, over distance and time can be gauged, thus giving information as to effective application rates, effective swath width, etc.. Reference papers illustrating this technique are given by Mount *et al* (1970)[13], Mount *et al* (1975)[12], Husted *et al* (1975)[5] and Rathburn and Boike (1972)[16].

5. INTRODUCTION TO TWO EXPERIMENTS

Mount, Lofgren, Pierce and Husman in 1968[10] carried out experiments (using methods 1 and 2 of section 4.), to produce a comparison between ULV and High Volume aerosols of naled. Their conclusion, relevant to this work, was that ULV aerosols of naled were more effective than High Volume aerosols against caged and free-flying mosquitoes.

The two experiments that follow do not compare ULV and High Volume techniques. They were carried out some two years apart, under different environmental conditions and in different localities, and, therefore, the results CANNOT be compared.

Experiment 1 attempts to estimate, in an urban situation, the effective distance of DIBROM 14 fogging (High Volume thermal application) from a vehicle-mounted fogging apparatus.

Experiment 2 attempts to estimate, under local prevailing conditions, the effective distance of DIBROM 14 ULV aerosol spray, dispersed from a vehicle-mounted apparatus.

However, the two experiments together do serve to investigate, and make familiar, an acceptable method for the bioassay evaluation (Method 1 Section 4.) of the effectiveness of insecticide application techniques.

So as not to introduce confusion the results of the experiments are not analysed by statistical methods, as would normally be the case. General trends can be observed and are discussed.

For the purposes of this bulletin little would be gained by following strict scientific procedure, the benefit lies in relating methods used in this field that could be of value in improving efficiency and effectiveness of control.

6. EXPERIMENT ONE

Measurement, using caged mosquitoes, of the effective range of naled (DIBROM 14) applied as a High Volume thermal fog, in an urban environment.

6.1 Aim

This work attempts to measure the effective swath width of the insecticide naled, dispersed as a thermal fog from a point source, under normal, close to ideal, conditions.

6.2 Experimental Method

The area chosen for the experiment was adjacent to a residential block in the Town of Canning, south-east of Perth. The experimental site was a brackish-water swamp, beside the Canning River and subject to tidal flooding. The swamp had a moderately homogeneous vegetation cover of Samphire Heath, Sedges and some Couch Grass, and was flanked on two sides by Paper-bark and Sheoak trees with a canopy some four metres high. It was a recognized breeding habitat for the Salt-marsh Mosquito *(Aedes vigilax)*.

A 140 m transect of ten cages of mosquitoes, each cage placed within 1.5 m of the ground, was set within the swamp. Although the cages were of three different sizes all were cuboidal in shape and constructed of a light metal frame, to which wire mesh (mesh size 2.5 mm) was fixed. Each cage had a sheet of white paper placed on the base side (floor).

A control cage of mosquitoes was placed outside the swamp away from the radius of effect of the insecticide.

The mosquitoes used in the experiment were of three species, *Aedes vigilax*, *Culex fatigans* and *Culex molestus*. They had been removed from a laboratory-housed wild stock and had no stress effects from insecticidal exposure before the test. All were younger than nine days.

The three species were mixed randomly in all cages. The density of mosquitoes per cage ranged from 0.003 - 0.133 mosquitoes per cubic centimetre, with a mean density of 0.01 mosquitoes per cubic centimetre (See Table 2 for actual numbers per cage). Small wads of cotton wool, saturated with sugar water solution were applied to each cage of mosquitoes, before and after (but not during) the test. These provided a food source to sustain the mosquitoes.

A thermal fog of naled (DIBROM 14) was produced from a TIFA (Todd Insecticide Fog Applicator), light-weight standard petrol unit, regulated for fine mist spraying at a rate of 48 litres per hour, at approximately 500°C. Naled was mixed at 3% with diesel oil. The fogger, mounted on the back of a truck, was stationed at one end of the test site in line with the transect and one metre from the first cage.

Fogging was carried out in the early evening (1800 hours) for 10 minutes. The air temperature was 25°C, with minimum wind (less than 3 km per hour), the drift was slight and away from the fogger. Thermal layering was minimal and the fog, once equilibrated with the air temperature, settled to ground level within four minutes of the start of fogging. The fog quickly reached the outer limit of the 140 m transect, and rose to an estimated vertical height of 50 m. No checks were carried out on particle size of the "fogged" insecticide, nor were measurements of dispersion rate made. The emphasis was on control under normal conditions.

Half an hour after the fog had been released, dead mosquitoes in each cage (ie. those that had fallen onto the white paper on the floor of the cage) were counted and removed by aspirator. This procedure was repeated after 1 hour, the cages were then collected and transported back to the laboratory. A mortality count was then taken 20 hours after the insecticide application. In this way progressive mortality was measured.

6.3 Results and Discussion

Table 2 shows the data from the 10 cages placed on the transect and from the control cage. Mortality rates are measured as percentage mortality at each of the time intervals.

It is evident that mortality decreases with distancee from the source of the insecticidal fog. This is the obvious, expected result. The concentration of the fog, and hence the insecticide, decreases from the source. Decreasing insecticide concentration will have a decreasing toxic effect upon caged mosquitoes and hence percent mortality will decrease.

The decrease in mortality along such a transect is ideally expected to approximate a linear function. This is not consistently observed in the results, (see Table 2) where at some distances mortality is greater than at the previous distance (ie. mortality, after half an hour, at 40 m from the source is 93% which is greater than the 51% mortality recorded at 31 m). However, the trend of decreasing mortality with increasing distance is generally observed.

It is similarly evident from Table 2 that mortality increases with time after exposure. There is little difference between mortalities (at each distance) between half hour and one hour intervals, however there is a large increase in mortality after 20 hours. It is important to note at this state that mortality in the control cage (not subjected to insecticide), was significant (10.2%) after 20 hours It is therefore probable that mortality within some test cages, after 20 hours, is not attributable wholly to the toxic effect of insecticide ie. some mortality counts at 20 hours may be artificially high. Taking this into account it is still evident that mortality increases with time.

Table 2 :

The effect of naled thermal fog on mosquito mortality on live caged mosquitoes over a 140 m transect. Expressed as % mortality.

Nos. Mosquitoes per cage	Density Mosquitoes per cm^3	Distance (m) from source	Percentage mortality		
			½ hr	1 hr	20 hrs
181	0.004	1	100	-	-
83	0.025	20	100	-	-
110	0.003	31	51	55	100
178	0.011	40	93	94	100
68	0.003	50	22	35	68
160	0.006	60	11	11	91
45	0.133	80	0	0	49
64	0.019	100	0	0	56
48	0.014	120	2	2	73
217	0.014	140	0	0	28
Control					
128	0.001	500	0	0	10

On the basis of these results, and using 90% mortality to define effective swath width, it is estimated that effective swath width would be approximately 40 - 50 m. Thereafter percentage mortality is greatly decreased. This is justified even at the 20 hour, 60 m mortality of 91.2% if we consider that this value is slightly higher than it should be (correction factor for mortality in control cage).

Finally, it must be recognized that an experiment using caged mosquitoes intrinsically gives artificially high mortality counts. This is due to the fact that the mosquitoes are caged and cannot escape the fog, as they may do if they were free-flying. Secondly mosquitoes were retained in cages that had been exposed to insecticide. Some insecticide would be present on the cage material and continue to affect the mosquitoes within the cage. In the natural situation mosquitoes may fly out of a fogged area and have no further contact with the insecticide.

7. EXPERIMENT TWO

Determination of the effective swath width of ULV naled applied under conditions, normal for the northern metropolitan region, Perth.

7.1 Aim

The aim of this work was to evaluate the effective swath width for aerosolized ULV naled applied under the conditions in which the insecticide would normally be used. An important aspect of the experiment was to make familiar the routine techniques available for evaluation of the effectiveness of insecticide application techniques.

7.2 Materials and Methods

The LECO Mini II ULV Aerosol Generator, mounted on the back of a utility truck was used for the experiment. This unit is described (in the instruction manual) as producing droplets of "optimum size". This specification was accepted.

DIBROM 14 insecticide was used on the basis of label recommendations, diluted with soya bean oil (1:1) and applied at the theoretical rate of 23 g/ha (0.02 lb/acre) of actual insecticide. Application rate was calculated on the basis of a vehicle speed of 10 km per hour and an effective swath width of 100 m (a convenient metric conversion from 300 ft.).

The flow meter on the LECO Mini II had previously been calibrated to the 1:1 DIBROM 14 - soya bean oil mixture.

The cages in which the mosquitoes were held were cylindrical, 25 cm in length and 10 cm in diameter. They were constructed of aluminium "flywire" netting on the sides and one end, supported by a PVC frame. To the other end was affixed a stockinged sleeve, which permitted access to the inside of the cage. With regard to cage construction, Breeland (1970)[2] indicated that the type of screening material used in test cages for evaluating ULV malathion treatments was important in making proper evaluations. Some types of screening were found to inhibit the penetration of droplets to the specimens inside the cages. His work showed that aluminium, bronze and plastic screening materials interfered with penetration more than other materials tested, while nylon and galvanized materials interfered least.

Culex annulirostris females were used in the experiment. They were caught within the field over a two-day period, maintained within a constant temperature room at 25^{0}C and 50% relative humidity in two-gallon plastic buckets and fed a 10% honey-water solution, for up to five days. From such storage they were transferred to the small cages, 25 mosquitoes per cage.

The experiment took place within a disused limestone quarry on the west side of Lake Joondalup north of Perth. A 100 m transect of cages, spaced at 10 m intervals was set up over bare ground. The cages were hung 1.2 m above the ground from wooden stakes. The transect lay along the prevailing direction of the wind, however, dramatic 90^0 wind shifts were evident (probably due to the quarry site). Two control cages were placed up-wind from the dispersal course. The twelve small cages containing mosquitoes were transported to the site in a polystyrene cooler box. No mosquitoes were found dead when the cages were distributed along the transect.

Wind velocities were recorded over a ten minute period before the test and for a two minute period while the aerosol was being dispersed.

The mosquitoes were placed on the transect between 6.30 and 6.35 pm. The spraying vehicle passed the transect at 6.40 pm. All cages were left in position for twenty minutes, and were then collected and placed within the cooler box. At this stage no mortality was recorded.

It was initially hoped to transfer each group of caged mosquitoes to a new holding cage uncontaminated by insecticide. The method, although satisfactorily tested in the laboratory, proved to be impossible in the field and was abandoned. Mortality counts were taken four and twelve hours after the experiment.

All twelve holding cages were supplied with honey-water solutions before and after the experiment.

7.3 Results and Discussion

Measurements taken at the time of experimentation, indicated that the wind was moderately strong and gusting (velocities ranged from 9.5 - 16.8 km/hr with an average of 11.8 km/hr).

Table 3 :

Percentage mortality of caged female *Culex annulirostris* placed along a transect exposed to ULV DIBROM 14.

Transect-metres from spray source	Cage No	% Mortality after four hours	% Mortality after twelve hours
10	1	100	-
20	2	100	-
30	3	100	-
40	4	100	-
50	5	100	-
60	6	100	-
70	7	100	-
80	8	92	100
90	9	92	100
100	10	40	100
Control $_1$	C_1	0	68
Control $_2$	C_2	4	72

As this test was being conducted it was thought that the wind conditions were excessively strong and variable - 90^0 wind shifts were occurring and the wind was gusting. As the aerosol was dispersed it was observed to blow back onto the vehicle, drift high into the air, and it was felt at the time that the insecticide would be dispersed too rapidly to be effective, however, the results have shown otherwise.

In this experiment per cent mortality was measured after four hours and again after twelve hours. The average mortality within the two control cages, after four hours, was 2%, compared with mortality of 40% or more for all experimental cages. This indicates that mortalities within the experimental cages at the four hour interval are a valid expression of the effect of the insecticide, and that mortality is not due to some other factor. On this basis, if effective swath is measured at 90% mortality, then the effective swath width, under the conditions of the experiment, was approximately 90 metres.

As has been mentioned, it was initially hoped to transfer the mosquitoes to clean cages after their exposure to the insecticide. This was not possible, and unfortunately all test cages and the two control cages were placed together in the confinement of the polystyrene holding box. It is this close association between control and contaminated test cages which is presumed to have led to an unacceptably high mortality count in the control cages at the twelve hour interval. This mistake in experimental procedure serves to highlight the effect that insecticide retained in test cages has on increasing mortality of mosquitoes, ie. the practice of keeping test mosquitoes in contaminated test cages artificially elevates the mortality rate above that of the natural situation in which mosquitoes are not confined to insecticide treated areas.

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<u>Mosquito Investigation No. 2. Shire of Wanneroo</u>
Bulletin No. 36, August, 1978

<u>A Means of Identifying the Common Mosquitoes of the Perth Metropolitan Area</u>
Bulletin No. 42, September, 1978

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