LABORATORY AND FIELD STUDIES ON MOSQUITO CONTROL IN WASTE DISPOSAL LAGOONS IN LOUISIANA

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The mosquito breeding potential of waste disposal lagoons has been reported by Eads and Mengies (1956), Beadle and Harmston (1958), Rapp (1960), Beadle and Rowe (1960), Rapp (1961), Myklebust and Harmston (1962), and Rapp and Emil (1965). Baseline susceptibility tests by Mulla *et al.,* (1960), Mulla (1961), Mulla *et al.* (1961), Mulla *et al.* (1962), Mulla *et al.,* (1964) and Keppler *et al.,* (1965) showed LD_{50} and LD_{90} data for susceptible laboratory strains of *Culex pipiens quinquefasciatus* (Say) to selected insecticides. Dosage mortality data on field-collected larvae of this species were obtained by Burton (1964) and Lofgren *et al.,* (1966). Wray (1959), reported that two applications of 8 percent DDT in fuel oil at a rate of 1 lb. per acre reduced larval populations as high as 90 percent in sludge lagoons. Steelman *et al.* (1966) showed that larvicide concentrations must be held to 1 ppm. or less in order to protect the bacterial flora necessary to the proper functional processes of the lagoon.

An increase in the number of stabilization lagoons used in connection with various types of livestock operations in Louisiana, along with recent reports of encephalitis have demonstrated the urgent need for mosquito control procedures. The southern house mosquito, *Culex pipiens quinquefasciatus* (Say), an important vector of the St. Louis strain of encephalitis, has reached larval populations as high as 1500 larvae per dipper in waste disposal lagoons in Louisiana.

MATERIALS AND METHODS. Larval *Culex pipiens quinquefasciatus* from an untreated swine lagoon were tested in the laboratory to determine baseline susceptibilities to eight insecticides. To reduce mortality, larvae were collected 24 hours prior to testing and held in groups of 500 in 16 x 10 x 2.5 inch enamel pans containing 2,500 ml. of glass distilled water at 27° C. The larvae in each pan were fed 1 gm. of pulverized rabbit feed, and only healthy larvae were used for testing purposes at the end of the holding period. All larvae were transferred with 96 mesh wire and eye droppers.

Technical grades of DDT, dieldrin, Dursban®, Baygon®, naled, fenthion, Abate®, and malathion were serially diluted with 95 percent ethanol such that 1 ml. added to 250 ml. of water would give the desired test concentration. Solid technical materials were dissolved with small amounts of acetone. The testing procedure and data processing were in accordance with the WHO insecticide susceptibility determination instructions (World Health Organization, 1960).

All materials listed above, with the exception of DDT and dieldrin, were tested as emulsifiable concentrates under field conditions by treating the lagoons with insecticide materials at a rate which would provide a 1 ppm. concentration of the insecticide in the total volume of lagoon water.

The amount of test material required for each lagoon was calculated as follows:

1. Length x width x depth = no. $ft.^3$ of water in lagoon
2. No. $ft.^3$ water in lagoon x no. gal. water/$ft.^3$ (7.5)
3. No. gal. water in lagoon was then used in standard insecticide spray formula to calculate the amount of emulsifiable material required to produce a .0001 percent (1 p.p.m.) concentration in total water volume of the lagoon.

Three methods of application were used to treat the lagoons. Two methods involved the use of a 50-gallon pressure

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sprayer applying the materials at 150 psi. to the lagoons. The amount of insecticide material required to produce 1 ppm. concentration in the lagoon was added to 50 gallons of water to facilitate more uniform distribution. In method one the material was pumped to the bottom of the lagoon and the pressure hose moved about at random on the bottom until the material was dispersed. In the second method using the 50-gallon sprayer the insecticide was sprayed over the surface of the lagoon with a standard livestock spray gun.

The third method of application involved the use of a 3-gallon hand pump sprayer equipped with a fan-type nozzle. The amount of insecticide material required to give a 1 ppm. concentration in the lagoon was poured into the sprayer and the sprayer subsequently filled to capacity with water. The material was applied by uniformly spraying the surface margins of the lagoon to a distance of 3 feet out from the bank.

Larval population samples were made with an enamel dipper 4.5 in. in diameter and 450 ml. capacity. One dip was made along the margin of the lagoon at 10-yard intervals with the average number of larvae per dipper being calculated and used as a population index.

Total bacterial population counts were made pre- and post-treatment to determine the effect of these materials on the bacterial flora under field conditions. Bacteriological techniques utilized were identical with those described by the Society of American Bacteriologists, (1957).

RESULTS AND DISCUSSION. Results of the baseline susceptibility tests are shown in Table 1. The most toxic materials tested were Dursban (LD_{50}=0.000135, LD_{90}=0.00068) and Abate (LD_{50}=.00054, LD_{90}=.0012). Dieldrin and Baygon appeared to be the least toxic.

Results of the field tests using 1 p.p.m. concentrations of selected emulsifiable concentrate insecticide materials are shown in Table 2. Dursban provided 144 days of 100 percent larval control while no apparent difference was demonstrated among Abate, fenthion, naled, and Baygon. Malathion gave only two days of 100 percent control.

No differences in effective mosquito control were observed between the three methods of application evaluated. However, due to ease of application, the method utilizing the hand-pump 3-gallon sprayer appeared to be the most desirable method for treating the lagoons.

No bacterial mortality occurred as a result of treating the lagoons with 1 p.p.m. concentrations of the materials tested.

The baseline and field test data suggest that residual chemical action retained in lagoons treated with 1 p.p.m. concentrations is sufficient to provide continued mosquito control until the chemical is broken down or diluted below the required lethal level. The length of time that effective mosquito control continues will vary depending on the insecticide material selected and the rate of dilution of the chemical.

TABLE 1.—Susceptibility of *Culex pipiens quinquefasciatus* to selected insecticide materials.

Material	p.p.m. Concentration	
	LD_{50}	LD_{90}
Abate	.00054	.0012
Baygon	.2	.7
Dursban	.000135	.00068
naled	.05	.063
fenthion	.051	.093
malathion	.049	.121
Dieldrin	.135	.67
DDT	.064	.205

TABLE 2.—Control of larval *Culex pipiens quinquefasciatus* in waste disposal lagoons.

Material *	Number days 100 % control
malathion	2
fenthion	18
naled	19
Baygon	20
Abate	20
Dursban	144

* Each emulsifiable concentrate formulation used at 1 p.p.m. concentration in the total volume of lagoon water.

Literature Cited

BEADLE, L. D., and HARMSTON, F. C. 1958. Mosquitoes in sewage stabilization ponds in the Dakotas. Mosq. News 18:293.

BEADLE, L. D., and ROWE, J. A. 1960. Sewage lagoons and mosquito problems. Proc. Symposium on Waste Stabilization Lagoons. U. S. Public Health Service, Kansas City, Mo.

BURTON, G. J. 1964. Results of insecticide resistance tests against larvae of *Culex pipiens quinquefasciatus* (Say) in British Guiana. Mosq. News 24(3):329–331.

EADS, R. B., and MENGIES, G. C. 1956. Texas mosquito problems from a species standpoint. Mosq. News 16(3):187.

KEPPLER, W. J., KLASSEN, W., and KITZMILLER, J. B. 1965. Laboratory evaluation of certain larvicides against *Culex pipiens* (L.), *Anopheles albimanus* (Wied.), and *Anopheles quadrimaculatus* (Say). Mosq. News 25(4):415–419.

LOFGREN, C. S., PENNINGTON, N., and YOUNG, W. 1966. Evaluation of insecticides against two species of *Culex* mosquitoes on Okinawa. Mosq. News 26(1):52–59.

MULLA, M. S. 1961. Susceptibility of various larval instars of *Culex quinquefasciatus* (Say) to insecticides. Mosq. News 21(4):320–323.

MULLA, M. S., AXELROD, H., and ISAAK, L. W. 1961. Effectiveness of new insecticides against mosquito larvae. Mosq. News 21(3):216–224.

MULLA, M. S., ISAAK, L. W., and AXELROD, H. 1960. Laboratory and field evaluation of new insecticides against mosquito larvae. Mosq. News 20(3):256–261.

MULLA, M. S., METCALF, R. L., and ISAAK, L. W. 1962. Some new and highly effective mosquito larvicides. Mosq. News 22(3):231–238.

MULLA, M. S., METCALF, R. L., and KATS, G. 1964. Evaluation of new mosquito larvicides with notes on resistant strains. Mosq. News 24(3):312–319.

MYKLEBUST, R. J., and HARMSTON, F. C. 1962. Mosquito production in stabilization ponds. Water Pollut. Cont. Fed. J. 34(3):302.

RAPP, W. F. JR. 1960. Sewage lagoon maintenance. Water Pollut. Cont. Fed. J. 32(6):660.

RAPP, W F. JR. 1961. Mosquito production in sewage lagoons. Proc. No. Cent. Ent. Soc. Amer 16:105–107

RAPP, W. F. JR., and EMIL, C. 1965. Mosquito production in a eutrophic sewage stabilization lagoon. Water Pollut. Cont. Fed. J. 37(6):867–870.

SOCIETY OF AMERICAN BACTERIOLOGISTS. 1957. Manual of Microbiological Methods. McGraw-Hill Book Co., Inc., New York.

STEELMAN, C. D., COLMER, A. R., CABES, L., BARR, H. T., and TOWER, B. A. (In press). Relative toxicity of selected insecticides to bacterial populations in waste disposal lagoons. J. Econ. Entomol. (Accepted for publication in 1966).

WORLD HEALTH ORGANIZATION. 1960. Insecticide resistance and vector control: tenth report of the expert committee on insecticide. WHO Tech. Rep. Series No. 191, pp. 25–29.

WRAY, F. C. 1959. Mosquito control in sludge lagoons. Mosq. News 19(2):81–3.