ARTICLES

A FIELD TRIAL OF LANDRIN AS A RESIDUAL HOUSE SPRAY IN EL SALVADOR[1]

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INTRODUCTION

An intensive search for alternative insecticides for use in malaria control operations has been carried out since DDT resistance in anopheline vectors was first reported. The evaluation of new insecticides for use in antimalaria campaigns has been promoted and coordinated by the World Health Organization (WHO). A regular screening system has been established, involving toxicological, entomological, and epidemiological evaluation, in several laboratories and in the field. The progress of this scheme has recently been reviewed by Wright (1971).

A carbamate insecticide, Landrin (OMS-597), was tested in village scale trials in 1967, and again in 1969, by the WHO Anopheles Control Research Unit I (ACRU-I) in Kaduna, Nigeria. In the first trial, an application rate of 2 gm/m^2 to hut interiors resulted in excellent control of *Anopheles gambiae* and *Anopheles funestus* for 90 days, in spite of data from bioassays which indicated a relatively short residual life. Other carbamates, such as propoxur, have an airborne phase which is effective in killing mosquitoes at some distance from sprayed surfaces. The fumigant properties of Landrin may also increase its effectiveness as an intradomiciliary spray. The trial in 1969, with an improved formulation, showed OMS-597 to be highly effective biologically for 4 months. The results of these village trials in Nigeria by ACRU-I have been summarized by Schoof (1972).

In Central America, malaria problem areas often coincide with areas of *Anopheles albimanus* resistance to DDT, dieldrin, malathion, and propoxur, although it is recognized that several other complex factors of vector and human behavior contribute to the continuing transmission of the disease. One part of the research program of the Central America Malaria Research Station (CAMRS) has been the field testing of promising new insecticides in areas of known vector resistance. In 1971, a small scale trial of Landrin, with entomological and chemical assessment, was carried out in a coastal vilage of El Salvador.

MATERIALS AND METHODS

Area of Study. The trial was carried out in the seaside village of La Zunganera in District San Juan Talpa, El Salvador. This typical coastal village consists of about 200 houses constructed from a great variety of materials, such as wood, palm thatch, brick, poles, cement, and wattle and daub. Preliminary entomological evaluation had shown a high anopheline density due to breeding in a nearby coastal estuary. Georghiou (1972) reported moderate to high resistance levels to a number of organophosphates and carbamates in

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Anopheles albimanus larvae collected from this general area in June 1971, and that resistance extended to the adult stage as well.

Spray Operations. The houses were sprayed in early July 1971, by five spraymen trained by the National Malaria Eradication Campaign and supervised by CAMRS personnel. The formulated insecticide for these trials was provided by Shell Development Company, Houston, Texas, U.S.A. A 5 percent suspension of Landrin was applied at a target dose of 2 gm/m^2, using Hudson X-pert sprayers of 8 liter capacity fitted with T-jet HSS 8002 nozzles. Suspensions of the 70 percent water dispersible powder (WDP) formulation were easily prepared, and did not clog nozzles or settle unduly in pump tanks. All inside wall surfaces of 197 houses were sprayed to a height of 3 meters from the floor. Twelve of these houses were resprayed approximately 12 weeks after the first cycle of spraying. No toxic symptoms were reported by spraymen or by householders during the entire course of the operation.

Entomology. The entomological evaluation of this trial was by weekly bioassay testing of sprayed surfaces, following techniques described in the Seventeenth Report of the WHO Expert Committee on Insecticides (1970). Wild-caught *Anopheles albimanus* females collected at night from stables near the village, were used for the bioassays. Mosquitoes were exposed for 30 minutes under plastic cones to wall surfaces of palm thatch, brick, wood, and mud. Approximately 150 specimens were exposed to each surface type weekly, and mortalities recorded 24 hours after exposure. Controls were exposed to unsprayed wood panels outside the treated houses.

Chemistry. The active ingredients of Landrin are a 4-to-1 mixture of the isomers of 3,4,5- and 2,3,5-trimethylphenyl methylcarbamate respectively. Air samples were collected from the interior of treated houses at regularly scheduled intervals following application. Greenburg-Smith impingers, charged with a solution of 0.05 N sodium hydroxide, were positioned within 4–6 inches from the treated surface and air drawn through the impinger by a battery operated unit. Air sampling was for a period of one hour duration at rates varying from 0.1 to 0.9 cubic feet per minute. The samples were then returned to the laboratory and a chloroacetate derivative of each isomer prepared which was easily detectable by electron capture gas chromotography. This method of sampling and analysis follows the technique described for propoxur by Miller *et al.* (1972).

Though the duration of these trials, records were maintained on the temperature and relative humidity at the time each air sample was collected. There was no significant change in either environmental factor during the two trial periods.

RESULTS

Air Sampling. The 2,3,5-trimethylphenyl methylcarbamate isomer was absent from half the air samples collected by the tenth day following initial application, and after 17–20 days neither isomer could be detected. Following the second spraying, the 2,3,5 isomer could still be detected after 63 days, at which time air sampling was discontinued.

Bioassays. Table 1 shows the results of 8 weekly bioassays for the four surfaces tested. Considering 70 percent of greater mortality to represent effective control of exposed anophelines, it appears that the period of activity was 5–7 weeks, depending on the surface tested.

Twelve of the test houses were resprayed 12 weeks after the first spray cycle, and weekly bioassays repeated, in order to see if multiple applications of this compound increased the persistence of effectiveness. Table 2 shows the bioassay results following the second spray application.

Figure 1 shows the mortality seen during the weekly periods following both spraying cycles. It is apparent that after the second spraying the average mortality remained above the 80 percent level for

TABLE 1.—Bioassay results of Landrin 1st cycle applied as an interior spray at 2 gm/m² in El Salvador, 1971.

Weeks after treatment	24 hour % mortality *				
	Palm thatch	Wood	Brick	Mud	Control
1	100(105)	92(162)	97(162)	97(137)	21(100)
2	100 (90)	92(127)	90(116)	98(55)	0(75)
3	100(150)	87(163)	86(170)	89(163)	5(122)
4	92(121)	89(170)	73(164)	74(145)	1(127)
5	79(151)	76(152)	71(170)	78(151)	2(137)
6	73(139)	65(157)	44(156)	64(141)	7(132)
7	76(150)	53(162)	55(137)	59(153)	1(128)
8	48(129)	69(165)	42(108)	68(90)	2(121)

* Test Insect: Wild caught female *Anopheles albimanus*. Numbers of mosquitoes exposed are given in parentheses.

the entire 12-week test period, at which time the trial was terminated, and that a second spraying enhanced the residual activity.

DISCUSSION

Residues of Landrin proved to be effective as an interior spray 5–7 weeks after the initial application and for at least 12 weeks following the second spraying, when testing by bioassays. It is suspected that with the first application, much of the chemical was tightly sorbed by the treated surfaces. The air sampling results indicate a limited amount of loss from these surfaces was occurring by volatilization. The slow, steady decrease in effective control could possibly be accounted for by continual loss of the chemical by volatilization at levels below detectability. Another explanation could be microbial degradation coupled with the irreversible binding of the insecticide at the sorption sites thus restricting contact toxicity. With the majority of these sorption sites occupied at the time of the second application, a greater amount of insecticide would be available for contact with the mosquito. That the chemical was free on the surface is reflected in the longer duration of time during which the insecticide was detectable in air and hence able to work freely under the change from the solid to the vapor state. Controlled laboratory experiments could more clearly identify the exact nature of this relationship.

The use of the Landrin 70 percent

TABLE 2.—Bioassay results of Landrin 2nd cycle applied as an interior spray at 2 gm/m² in El Salvador, 1971.

Weeks after treatment	24 hour % mortality *				
	Palm thatch	Wood	Brick	Mud	Control
2	99(159)	92(154)	93(151)	95(112)	7(108)
4	96(147)	98(160)	99(166)	99(94)	4(115)
5	100(86)	84(89)	94(89)	100(89)	8(75)
6	96(160)	96(162)	97(168)	89(120)	2(125)
7	95(163)	99(176)	95(167)	96(141)	3(118)
8	63(57)	86(97)	89(107)	92(84)	2(85)
9	93(88)	85(109)	91(104)	100(104)	0(113)
10	98(144)	87(101)	74(109)	99(101)	0(111)
11	81(153)	86(148)	76(163)	86(147)	0(132)
12	90(146)	99(172)	91(164)	89(145)	5(130)

* Test Insect: Wild caught female *Anopheles albimanus*. Numbers of mosquitoes exposed are given in parentheses.

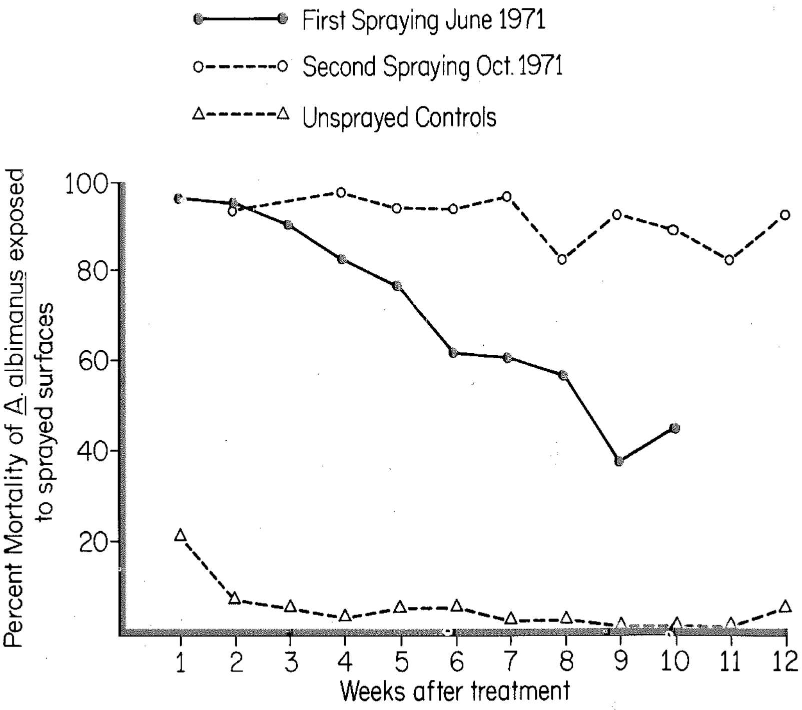

FIG. 1.—Mortality of *An. albimanus* following spraying cycles.

WPD formulation presented no operational problems, and this compound could be considered as a candidate insecticide for spraying in areas where the malaria vector is resistant to DDT, dieldrin and malathion.

SUMMARY

A small scale field trial of Landrin (OMS-597) as a residual spray in houses was carried out during 1971 in a coastal village of El Salvador, in an area where the malaria vector *Anopheles albimanus* was moderately to highly resistant to DDT, dieldrin, malathion, and propoxur. During this trial, 197 houses were sprayed, and residues tested weekly by bioassay, using wild caught female *Anopheles albimanus*. Surfaces tested were palm thatch, wood, brick, and mud. Following the initial spraying the period of effective residual action was 5–7 weeks. Selected houses were then resprayed and bioassays repeated. Residues on all four types of surfaces were effective for the entire 12-week test period following the second spray application. No operational problems were encountered with the Landrin formulation used, and there were no signs of human toxicity during the trials.

Air sampling showed that the insecticide was no longer detectable in air inside sprayed houses 17 to 20 days following the initial application. The compound could be detected in air samples taken 63 days after the second spray application.

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INFLUENCE OF GRIDS ON MOSQUITO OVIPOSITION IN STEEL CEMETERY VASES[1]

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Flower vases and urns in cemeteries can be prime sources of container-breeding mosquitoes (Shanafelt 1969). These vases and urns are of various sizes, but in the more modern cemeteries, by far the greater number are round, galvanized steel, slightly more than 6 inches deep, and slightly less than 4 inches in diameter. They are purchased with, and designed to fit into, galvanized steel casings within which they can also be stored in an inverted position when not in use. Since the casings can be installed flush with the terrain in soil or in concrete, they can be mowed over or driven over with rubber-tired vehicles when not in use without harming the casings or the vases or otherwise interfering with cemetery maintenance. If wilted or spent flowers are promptly discarded and the vases are inverted, mosquito production in cemeteries can be greatly lessened and in some instances even eliminated. But when the inverting process is neglected, mosquito production may result.

The wilting of natural flowers therefore indicates when the flowers should be discarded and the vases inverted. However, when artificial flowers are used, this built-in timetable disappears. Undoubtedly—and understandably—most caretakers are reluctant to arbitrarily discard well-preserved, expensive artificial flowers. Quite obviously, though artificial flowers need no moisture to prolong their attractiveness, rainfall or sprinklers may cause water to accumulate in the containers and thus cause the containers to become mosquito-producing habitats that may require periodic treatments with insecticides.

A very real problem, then, and the one to which this paper is addressed, is how to avoid mosquito production in the steel containers in cemeteries without the use of insecticides—and independent of the method of handling by caretakers—or without lessening their adequacy and availability for use with either natural or artificial flowers.

Our approach to the problem has been to divide the surfaces of the water into smaller segments with grids with various sized spacings. This approach was based on the assumption that under field conditions where some choice could be exercised, *Culex pipiens quinquefasciatus* Say, our target species, would not deposit egg masses on an extremely small surface. Indeed, in the absence of proof to the contrary, we would be reluctant to concede that *C. p. quinquefasciatus* would deposit egg masses in a container, however deep it

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