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A FIELD STUDY OF AN AIRBORNE TOXIC EFFECT OF BAYGON[1] RESIDUAL SPRAY

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Few studies have been carried out on the "fumigant" effect of residual insecticides. Davidson (1952), in commenting on the mortality occurring among mosquitoes in cages hung in sprayed houses, but not in contact with sprayed surfaces, considered that this was due, in the case of DDT and dieldrin, to airborne particles and in the case of HCH to fumigant and particulate effects. The airborne effect has not been studied sufficiently to assess its role in the control of vector-borne diseases. Neither has the actual mechanism of this effect been thoroughly examined. Attention is now being given to this matter in connection with the WHO Program for the Evaluation and Testing of New Insecticides.

Baygon has been shown to be an effective insecticide for controlling anophelines (Gahan *et al.*, 1966; Pant and Self, 1966; Pant *et al.*[4]). Unpublished reports from WHO/PAHO Insecticide Testing Team in El Salvador showed that when mosquitoes were caged in the vicinity of sprayed surfaces they were killed. It was concluded by the above team that the lethal effect of this insecticide was due to microparticles floating in the air.

Pant and Self (1968) showed that mosquitoes were knocked down when exposed to glass plates treated with Baygon without actually coming in contact with the insecticide. An unpublished report of the *Anopheles* Control Research Unit, Kaduna[4] has also shown that the rate of loss of the active ingredient of Baygon from the insecticide-impregnated cheesecloth was very rapid and was in conformity with the half life of this material on glass fiber filters reported to be of the order of 13 days by Hadaway.[5] Baygon has the vapor pressure of 0.01 mm Hg at 120° C.[6]

Because biting and resting activities of malaria vectors frequently take place in the immediate vicinity of huts, it might be an advantage to have an insecticide which would not only kill those anophelines resting on a sprayed surface but would also kill those not in direct con-

[1] Ortho-isopropoxyphenyl methylcarbamate, also known as Unden, Bayer 39007, OMS 33, arprocarb, and propoxur.

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[4] Unpublished report of the WHO *Anopheles* Research Unit, Kaduna, 1966, submitted by C. P. Pant, L. S. Self, M. Ramasamy and P. Renaud, WHO Document VBC/67.15.

[5] Unpublished communication by A. B. Hadaway to WHO, from the Tropical Pesticides Research Unit, Porton, U.K.

[6] Pesticides Chemicals Official Compendium, Association of American Pesticides Control Officials, Inc., 1966.

tact. Since field trials of Baygon indicated that it had an airborne lethal effect on mosquitoes at some distance from the sprayed surfaces, investigations were undertaken in the field to assess the extent and duration of this effect.

Some laboratory studies on this effect were also carried out.

MATERIALS AND METHODS. Special bioassay tests were conducted at weekly intervals to observe the airborne toxic effect of Baygon in the village of Angwan Tuta near Kaduna, Nigeria in 1967. The village occupied an irregular area and contained 206 structures with 4963 m^2 of sprayable surface area. A total of 10.9 kg of Baygon (21.8 kg of a 50 percent formulation) was applied giving an overall dosage of 2.2 g/m^2. Ten to 20 laboratory bred, freshly blood-fed *Aedes aegypti* were placed in cages (5 in. x 2.5 in.) made of mosquito netting supported by an iron-wire frame. These cages were hung at the center of each treated hut at 1 ft. to 4 ft. from the ground and at various distances ranging from 1 to 550 ft. measured from the nearest treated hut. Cages were distributed just after sunset (6 p.m. to 6:30 p.m.) and removed next morning just before sunrise (6 a.m. to 6:30 a.m.). Mosquitoes kept at the distances of 325 and 550 ft. were beyond the edge of the village and served as checks.

After exposure, mosquitoes from the individual cages were transferred to separate paper cups. During the following 24 hours mosquitoes were provided with a 5 percent glucose solution.

In the laboratory an "airbioassay" apparatus was assembled consisting of a mosquito chamber connected on one side to a filter pump and on the other to two wash bottles connected in a series through sintered glass filters (porosity 1, i.e. 90–100 microns). A deposit of Baygon was evaporated on the sides of the glass bottle furthest from the mosquito chamber. A cotton plug was placed between the chamber and the bottles (Fig. 1).

RESULTS. Two days after spraying, all mosquitoes caged inside and within 27 ft. of sprayed huts were killed (Table 1). Fifty-seven percent of those caged at 101 ft. were also killed. Mortality rates observed at 160, 325 and 550 ft. were negligible, thus suggesting the absence of effects due to handling and/or other non-specific causes. At 10 to 13 ft. from the sprayed houses, 96.7 percent mortality was observed on the 9th day and 61.2 percent

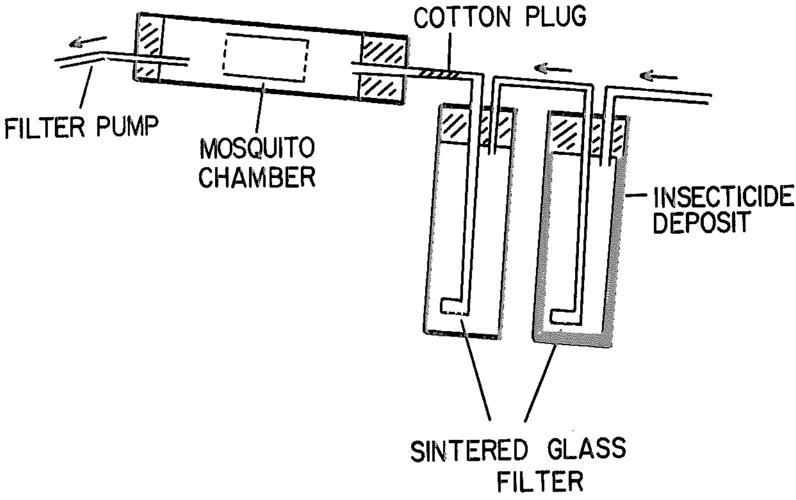

FIG. 1.—Diagram of apparatus used to test airborne effect of Baygon deposits.

TABLE 1.—Bioassay of airborne effect of Baygon at Kaduna, Nigeria, 1967.

Distance from nearest sprayed hut—feet	Days after spraying at 2 g/m^2											
	2	9	16	23	30	37	44	51	59	65	72	79
	Percentage mortality after 24 hours											
550	6 (16)	0 (20)	0 (14)	0 (16)	0 (20)	0 (20)	0 (17)	0 (20)	0(21)	..	..	..
320	0 (13)	6 (16)	6 (18)	0 (15)	0 (17)	0 (19)	0 (18)	0 (18)	0(16)	..	..	..
160	..	8 (13)	5 (20)	0 (17)	0 (19)	0 (20)	..	..	..	..	..	..
101	57 (14)	33 (12)	7 (14)	0 (18)	5 (19)	0 (22)	..	..	..	..	..	..
27	100 (26)	97 (29)	41 (39)	0 (33)	17 (42)	0 (40)	..	..	..	..	..	..
10–13	100 (28)	97 (29)	61 (36)	8 (64)	4 (75)	1 (82)	..	..	..	..	..	..
5–7	..	..	..	71 (63)	54 (79)	5 (79)	..	..	..	..	..	..
1–4	100(180)	100(145)	99(168)	84(183)	70(237)	43(246)	33(258)	4(358)	2(42)	..	..	..
Inside huts	100 (64)	100 (35)	100 (29)	99 (75)	100 (78)	100 (76)	100 (61)	96(198)	62(27)	80(343)	66(367)	56(394)

Note: Figures in parentheses show number of *Aedes aegypti* exposed in cages from 18.00 to 06.00 hours.

on the 16th day after spraying. Seventy percent or more of mosquitoes died on most occasions when caged at 1 to 4 ft. from sprayed houses through 30 days after spraying, and inside houses up to 65 days. More than 50 percent of the mosquitoes inside houses were killed on the 79th day after spraying (the end of observations).

Mosquitoes in the airbioassay apparatus were knocked down within 15 to 20 minutes of exposure to air currents drawn through the system containing the filters and Baygon deposit. When a cotton plug was introduced in addition to the filters, the time required to produce knockdown increased to 60 to 120 minutes. In the absence of the insecticide, no mortality was observed.

CONCLUSIONS. The observations confirm that Baygon has an airborne phase which is quite effective in killing mosquitoes in sprayed houses for more than two months, even though they do not rest on sprayed surfaces. This effect also extends for some distance from sprayed houses diminishing with distance and elapsed time after spraying.

In the sprayed houses Baygon is absorbed by mud surfaces and is effective longer in killing mosquitoes than would be indicated by its half-life on glass-fiber filters.

The effectiveness of Baygon in compact sprayed villages has been greater than would have been expected from experimental hut trials. It is considered that this is due to its airborne phase which apparently extends from one house to another when they are in close proximity.

These emanations are capable of passing through sintered glass filters and through a cotton plug. The exact nature of these may be microparticulate, vapor phase or both.

This airborne phase is considered to be a "bonus" effect of this insecticide which may be found quite useful in the control of diseases where peri-domiciliary transmission by vectors occurs or when the vectors enter houses, bite, and escape to rest nearby without actually having a lethal contact with sprayed walls.

SUMMARY. Baygon sprayed as a residual insecticide in a village has been shown to exert an airborne toxic effect on mosquitoes. This effect is most pronounced in the immediate vicinity of and inside the huts up to a period of 1 and 2 months respectively after spraying. The mortalities produced due to this effect are in inverse proportion to the distance from the treated huts and the days elapsed after spraying. This may provide a "bonus" in the performance of Baygon as a residual insecticide for control of vector-borne diseases.

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