AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
Batch 69

1. SUBJECT CLASSIFICATION
A. PRIMARY: Health — NS00-0000-G226
B. SECONDARY: Tropical diseases

2. TITLE AND SUBTITLE
Initial field studies in Upper Volta with dichlorvos residual fumigant as a malaria eradication technique,1: General considerations

3. AUTHOR(S)
Quarterman,K.D.; Lotte,M.; Schoof,H.F.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1963	6p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
HEW/PHS/CDC

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*
(In WHO. Bul.v.29,p.231-235)

9. ABSTRACT

10. CONTROL NUMBER
PN-AAE-289

11. PRICE OF DOCUMENT

12. DESCRIPTORS
Field tests
Upper Volta
Fumigation
Malaria

13. PROJECT NUMBER

14. CONTRACT NUMBER
PASA 5903-7 Res.

15. TYPE OF DOCUMENT

Bull. Org. mond. Santé
Bull. Wld Hlth Org. } 1963, **29**, 231-235

AN-AAE-250
REPRINT NUMBER
Copy 1 of 3
PA
HEW/PHS/CDC

Initial Field Studies in Upper Volta with Dichlorvos Residual Fumigant as a Malaria Eradication Technique*

1. General Considerations

K. D. QUARTERMAN,[1] M. LOTTE[2] & H. F. SCHOOF[3]

Laboratory and simulated field tests have shown that dichlorvos, a volatile insecticide, can be prepared in a solid formulation which releases the dichlorvos vapour over a period of several months at a relatively uniform rate high enough to kill adult anopheline mosquitos but low enough to have no effect on man and the higher animals.

A field experiment is in progress in Wakara, Upper Volta, to evaluate the residual fumigant technique under practical field conditions. Chemical, biological, toxicological and epidemiological data obtained during the first nine months indicate that the method produced dichlorvos vapours in a concentration effective against mosquitos for 3 to 5 months per treatment, that the occupants of the treated dwellings showed no detectable effects from the insecticidal vapours, and that the malaria rates were reduced by 38%-55% among the population of the treated village as compared with a nearby untreated control village.

Preliminary laboratory and simulated field tests at Savannah, Ga., USA, in 1958 revealed the potentialities of a new concept in malaria eradication—the use of the residual fumigant technique for the control of house-frequenting vectors of disease (Mathis et al., 1959). Subsequent studies (Miles et al., 1962) resulted in the development of dichlorvos (O,O-dimethyl-2,2-dichlorovinyl phosphate)[4] vapour dispensers, which gave effective kills of adult female *Anopheles quadrimaculatus* with overnight exposures in plywood huts for periods ranging up to 12-16 weeks (Mathis & Maddock, 1961; Mathis et al., 1961).

Dosage mortality investigations with dichlorvos vapour showed that a concentration of 0.015 μg of dichlorvos per litre of air would produce complete mortality of adult female *A. quadrimaculatus* following a 4-hour exposure (Maddock & Sedlak, 1961). Preliminary studies on the safety of dichlorvos for aircraft disinsection (Witter et al., 1961; Hayes, 1961) indicated that air concentrations of dichlorvos greater than that required for complete mosquito mortality could be tolerated by man with no detectable effect. In 1960, the American Conference of Governmental Industrial Hygienists (1960) established 1.0 μg per litre of air as the accepted safe allowable air concentration of dichlorvos in industrial plants, based on an 8-hour working day. On the basis of these data, there appeared to be a wide margin of safety within which the residual fumigant technique with dichlorvos might be used safely. Consequently, it was considered desirable to evaluate the biological effectiveness of the technique in occupied dwellings under practical field conditions and to verify the apparent safety of the method, even though further improvements in the dichlorvos dispensers were to be expected. To accomplish these objectives, a co-operative experiment was undertaken jointly in 1961 by the Communicable Disease Center, Savannah, Ga., and the Centre Muraz, Bobo-Dioulasso, Upper Volta.

---

* These studies were accomplished as part of a contractual agreement between the Communicable Disease Center, Savannah, Ga., and the Agency for International Development.

[1] Chief, Technical Development Laboratories, Technology Branch, Communicable Disease Center, Public Health Service, US Department of Health, Education, and Welfare, Savannah, Ga., USA.

[2] Director, Centre Muraz, Organisation de coopération et de coordination pour la lutte contre les grandes endémies, Bobo-Dioulasso, Upper Volta.

[3] Chief, Biology Section, Technical Development Laboratories, Technology Branch, Communicable Disease Center, Public Health Service, US Department of Health, Education, and Welfare, Savannah, Ga., USA.

[4] Also known as DDVP.

DESCRIPTION OF TEST AREA

A survey of potential test sites was made, and the Bobo-Dioulasso area in Upper Volta was selected. In this area, the rainy season extends from about 1 June into October. During the latter part of the dry season, which prevails from November to May, the area becomes semi-arid.

Anopheles gambiae and *A. funestus* are the principal malaria vectors, with *A. nili* next in importance. Mosquito populations and malaria transmission reach their peak in late August and September. Although the mosquito population declines rapidly after the end of the rainy season, mosquitos are readily found in the houses and malaria transmission occurs throughout the year. Malaria in this area is caused predominantly by *Plasmodium falciparum*, with *P. malariae* next in importance.

The village of Wakara, located about 100 km from Bobo-Dioulasso, was selected for treatment. It is composed of some 700 houses and a population of approximately 1100 people, principally of the Bwaba tribe. Most of the houses are constructed of adobe with a flat roof of the same material supported by wooden poles (Fig. 1 and 2). A few circular houses were constructed with adobe walls and a thatched roof or were made entirely of straw.

The adobe houses were of four general types: (1) single room; (2) two rooms of similar size; (3) a large room with partial partitions; and (4) multiple rooms of various sizes. The volume of the houses ranged from about 500 to 5000 cubic feet (approximately 14-140 m^3). Most of the houses had a circular vent in the ceiling, approximately 12 inches (30 cm) in diameter, which was open or closed depending upon the season of the year and the use being made of the room. Many of the houses were without windows, and when windows were present there was no uniformity as to size, shape, or location. The majority of the windows were less than 18 inches (45 cm) square, and many were smaller than 12 inches (30 cm) square.

From two to five or more houses may be connected by a mud wall to form an enclosed compound. Usually the several houses are occupied by one family group. Some of the houses have a porch-like enclosure, roofed and with two or three walls but with no wall on the side opening on to the compound. This porch enclosure, as well as the open compound, provides storage and serves as a place for the people to congregate.

The houses contain little or no furniture, but many articles and utensils of all kinds and sizes. Most of the houses have a storage room where food and other items are kept and which is not generally used for sleeping. Ordinarily, most of the people sleep indoors on grass mats spread on the floor, but in the hottest weather some sleep on the porch enclo-

FIG. 1
EXTERIOR VIEW OF A TYPICAL HOUSE IN WAKARA, UPPER VOLTA

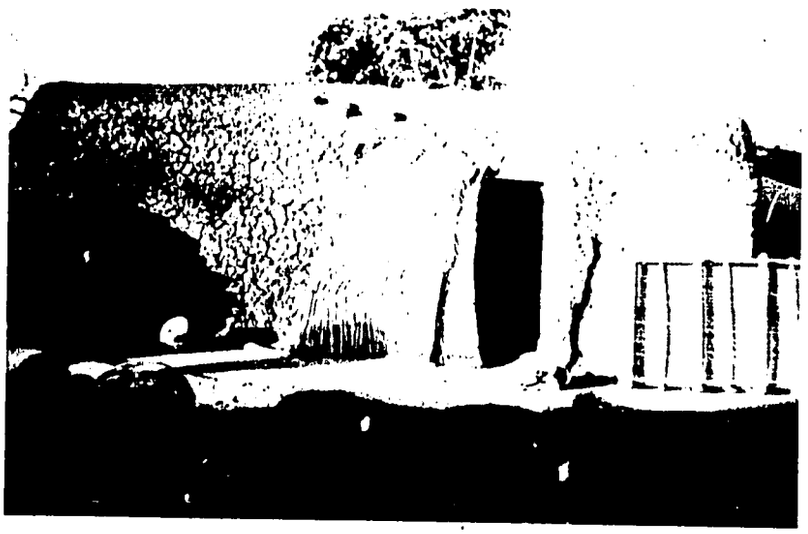
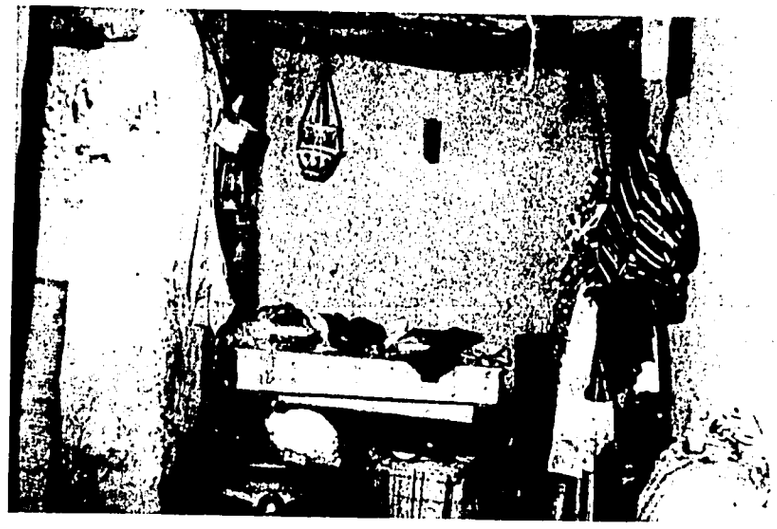


FIG. 2
INTERIOR VIEW OF A TYPICAL ROOM IN WAKARA, UPPER VOLTA



Two dichlorvos dispensers are shown in place, one in right foreground, the other at centre rear.

sures or in the open compound. The windows and doors of the houses are usually closed at night, except in the hottest weather.

In the evenings the people may sit in the open compounds or porch enclosures for several hours after dark. Dancing and other festive activities occurred at weekly or more frequent intervals. On these occasions the participants were often out of doors until after midnight.

A Roman Catholic mission is located approximately 500 m from Wakara. The mission is composed of a group of several masonry buildings—a church, a school, a dispensary, and several storehouses and adobe residences. The mission serves as the Christian religious centre for a large surrounding area. The people of the area visit the mission frequently, and there is some movement of people into and out of Wakara throughout the year.

Approximately 1 km from Wakara are the cattle pens, in an area known as Camp Peulh. The cattle tenders are of a different tribal group from the Bwaba tribe, and they live at the pens in houses constructed entirely of woven straw. The dichlorvos treatment of Wakara included the mission and Camp Peulh areas.

The village of Sara, located approximately 30 km from Wakara, served as the untreated check village. It is slightly smaller in size than Wakara, but is similar in other respects, including the type of house construction.

PROCEDURE

Preliminary studies in Bobo-Dioulasso [1] in the fall of 1960 indicated that the dichlorvos dispensers would perform satisfactorily in the mud houses prevalent in that area, but that the air concentrations of dichlorvos were somewhat lower than those obtained with a similar treatment in plywood huts at Savannah, Ga.

The main experiment in 1961 was designed to obtain chemical, biological, toxicological and epidemiological data. Since Wakara represented a very small isolated area of insecticidal treatment surrounded by vast areas of holoendemic malaria, at the time the village itself was first treated with the dichlorvos dispensers a residual application of DDT was made in all houses within a radius of 10-15 km around Wakara. The purpose of the DDT treatment was to reduce the possible infiltration of infective mosquitos into Wakara. A similar application of DDT was made to all houses within 10-15 km of the untreated check village of Sara.

[1] Conducted by Dr J. W. Miles and Mr Willis Mathis of the Communicable Disease Center and Mr M. Eyraud of the Centre Muraz.

To facilitate operations, each house in Wakara was given a number. The first treatment of Wakara began on 26 June 1961 and was completed on 6 July. The dichlorvos dispensers were placed in the houses at the rate of one dispenser per approximately 750 cubic feet (21 m^3), with a range of one dispenser per 500-1000 cubic feet (14-28 m^3). The second and third treatments, applied between 8 and 22 August and 23 October and 1 November, respectively, were made at the rate of one dispenser per approximately 500 cubic feet.

The dispensers [1] were composed of 25% technical dichlorvos in a mixture of 75% montan (lignite) No. 16 wax and 25% dibutyl phthalate. Each dispenser was approximately 1½ inches (3.8 cm) in diameter and 6 inches (15 cm) long, and weighed approximately 200 g. During manufacture, the dispensers were sealed in plastic tubing that was impervious to dichlorvos vapours. At the time of installation, the tubing was removed and each dispenser was placed in a metal cage constructed of 4×4 mesh galvanized hardware cloth. The caged dispensers were suspended with wire from the ceiling rafters at about the 7-foot (2-m) level.

The dispenser cages were used as a safety precaution to prevent children or animals from coming into contact with dispensers that might be knocked down accidentally. Light work gloves were worn by the workers when handling the dispensers. Discarded dispensers were buried.

For the entomological evaluations,[2] approximately 25 houses were selected as representative of the village as a whole. For the toxicological evaluations,[3] six houses were selected on the basis of the number and age-grouping of the occupants. The air sampling and the chemical analyses to determine the air concentrations of dichlorvos, for correlation with biological and toxicological data, were conducted in these and other selected houses. The malariometric evaluation [4] was based on parasite surveys made in Wakara and Sara before treatment and then periodically after the first treatment.

RESULTS

Details of the results achieved may be found in the three following articles,[2-4] which form Parts 2, 3 and 4 of this series of papers. These results may be summarized briefly as follows:

1. The dichlorvos dispensers used in this experiment, when installed in the mud houses prevalent in Wakara at the approximate rate of one dispenser per 500 cubic feet (14 m^3), were biologically effective for approximately three months during the wet season and up to five months during the dry season.

2. The residual fumigant technique, with the type of dichlorvos dispenser employed in this experiment, did not produce any detectable effect on the occupants of the treated houses.

3. From the data for the small populations of children in the study villages, the malaria parasite rate in infants in Wakara under 1 year of age was reduced by approximately 55% at nine months after treatment with dichlorvos was begun, as compared with the rate in the untreated check village of Sara; the parasite rate in children 1-9 years old was reduced by approximately 38%.

DISCUSSION

The results obtained during the first nine months of this continuing experiment are most encouraging. The toxicological data indicate a satisfactory margin of safety from any effect of the dichlorvos vapour on people living in houses treated by the residual fumigant technique. The reduction that has occurred in malaria rates substantiates the entomological data, indicating that the dichlorvos residual technique was effective in killing mosquitos resting in the treated houses. Whether the decline in malaria incidence will continue until no further transmission is occurring in Wakara is quite problematical, particularly if extra-domiciliary transmission or the occurrence of infection while the residents of Wakara are travelling outside the treated area is a factor. Under such circumstances, neither the residual fumigant technique nor residual treatments could achieve eradication in such a small experimental area.

The results of this field study indicate that in houses of relatively tight construction the present dichlorvos dispensers could be used effectively with a treatment cycle of approximately three to five months depending upon the prevailing weather conditions. The authors are certain that the present dispenser (dichlorvos/montan wax/dibutyl phthalate) can be developed further so as to improve the utilization of dichlorvos and the consequent efficiency of the dispenser.

---

[1] The dispensers were prepared by the Chemistry Section, Technical Development Laboratories, Technology Branch, Communicable Disease Center, Savannah, Ga., USA.

[2] See the article by Mathis et al. on page 237 of this issue.

[3] See the article by Funckes et al. on page 243 of this issue.

[4] See the article by Escudié & Sales on page 247 of this issue.

The experiment in Wakara will be continued at least through 1962 to obtain a clearer picture of the extent to which malaria transmission may be reduced under the rather difficult test conditions prevailing in this small experimental area, and to evaluate the performance of improved dispensers. The results on the biological effectiveness and on malaria transmission, as well as on the safety of the technique, are sufficient to warrant the extension of testing of the technique to other malarious areas.

ACKNOWLEDGEMENT

A significant quantity of the dichlorvos used to make the dispensers for this experiment was furnished for that purpose through the courtesy of the Shell Chemical Company, New York.

RÉSUMÉ

Des tests de laboratoire ont montré que le Dichlorvos (DDVP), insecticide volatil, peut être présenté sous forme d'une cartouche solide, pesant environ 200 g et contenant 25% de DDVP incorporé à un mélange où figurent 75% de cire et 25% de dibutyl phtalate. Chaque cartouche est, au moment de son emploi, placée dans une cage métallique que l'on suspend à 2 m du sol. Il s'en échappe alors des vapeurs et ceci pendant plusieurs mois. Ces vapeurs contiennent assez d'insecticide pour tuer les anophèles adultes, mais sont sans danger pour l'homme et les vertébrés supérieurs.

Une expérimentation sur le terrain est actuellement en cours à Wakara, Haute Volta, afin d'évaluer la technique de fumigation. Pendant les neuf premiers mois, les faits chimiques, biologiques, toxicologiques et épidémiologiques recueillis montrent que, grâce à cette méthode, des vapeurs de DDVP se sont dégagées pendant 3 à 5 mois en une concentration toxique suffisante contre les moustiques, sans que les occupants des habitations ainsi traitées aient souffert de ces émanations. Le pourcentage des cas dans ce village où le paludisme est holoendémique s'est abaissé de 55% à 38%, un village voisin non traité servant de témoin.

REFERENCES

American Conference of Governmental Industrial Hygienists (1960) *Arch. Environ. Hlth*, **1**, 140

Hayes, W. J., jr (1961) *Bull. Wld Hlth Org.*, **24**, 629

Maddock, D. R. & Sedlak, V. A. (1961) *Bull. Wld Hlth Org.*, **24**, 644

Mathis, W., Fay, R. W., Schoof, H. F., & Quarterman, K. D. (1959) *Publ. Hlth Rep. (Wash.)*, **74**, 379

Mathis, W. & Maddock, D. R. (1961) *Mosquito News*, **21**, 86

Mathis, W., Miles, J. W. & Schoof, H. F. (1961) *Bull. Wld Hlth Org.*, **24**, 646

Miles, J. W., Pearce, G. W. & Woehst, J. E. (1962) *J. Agric. Food Chem.*, **10**, 240

Witter, R. F., Gaines, T. B., Short, J. G., Sedlak, V. A. & Maddock, D R. (1961) *Bull. Wld Hlth Org.*, **24**, 635