Bull. Org. mond. Santé
Bull. Wld Hlth Org. } 1960, 22, 757-765

Gamma-BHC/Cereclor—A New, Long-Acting Lindane Formulation for Malaria Control

K. S. HOCKING,[1] J. A. ARMSTRONG [1] & F. S. DOWNING [2]

Sorption of insecticides by muds and other materials used in the construction of native huts prolongs their duration of action or persistence. The use of gamma-BHC as a residual insecticide has been limited by the fact that its sorption by most materials is of a low order, so that it is comparatively short acting. If gamma-BHC is melted with a resin, the solid solution can be converted into a water-dispersible powder which is much more persistent on sorptive and semi-sorptive surfaces. Laboratory experiments had shown that the best results were obtained with a proprietary resin known as Cereclor. Field trials conducted by the authors have now demonstrated that this formulation retained its efficacy for at least six months, even on surfaces of low sorptive power, such as thatch and sisal. Gamma-BHC alone was much less persistent, except on mud walls, but even here bioassay showed the formulation with Cereclor to be more active. The authors consider that gamma-BHC/Cereclor approximates to the ideal insecticide for the spraying of native huts in malaria control.

INTRODUCTION

Although gamma-BHC is highly toxic to anophelines, and even more toxic than DDT or dieldrin to *Anopheles gambiae* Giles (Armstrong, 1958), its use as a residual insecticide in houses for malaria control has been limited by the fact that its persistence is generally lower than that of the other two insecticides except on some mud surfaces. The degree of persistence was found by Hadaway & Barlow (1952) to depend on the sorptive capacity of the substrate. Muds could have high or low sorptive capacity, and this caused long or short persistence respectively. Timber and thatch had low sorptive powers. In field trials at Taveta, Kenya, with native-type houses, Davidson (1953) found that gamma-BHC as a dispersible powder would persist for only three months on the mud lining of a hut. Burnett (1957) subsequently showed that the mud used by Davidson had a low sorptive activity and that 0.25 mg of gamma-BHC per square metre as a dispersible powder on a highly sorptive mud gave up to 80% mortality of *A. gambiae* females entering the houses six months after spraying, and 50%-60% mortality after twelve months.

Field trials with substrates like timber or thatch have been limited to a single trial by Burnett (1957) who found that 0.25 mg of gamma-BHC per square metre gave 50% mortality of *A. gambiae* females four months after application in African-type houses lined with banana leaves. Hadaway & Barlow (1958) found in laboratory work that 50 mg of gamma-BHC per square foot (0.5 g of gamma-BHC per square metre) had lost its toxicity to *A. stephensi* females on such surfaces as plywood and thatch after storage at 25°C for one to two months.

For ideal malaria control with such an efficient vector as *A. gambiae*, gamma-BHC must give in practice a 50%-60% mortality of female anophelines entering houses (Macdonald & Davidson, 1953) for at least six months, no matter what type of surface is used for lining the houses. This is not possible with straight gamma-BHC. It has been known for many years that resins of various kinds deposited with BHC from a solvent have the effect of increasing the persistence of BHC deposits on non-porous surfaces. For example, the experiments of Hornstein & Sullivan (1953) showed that a mixture of gamma-BHC and a chlorinated polyphenyl resin deposited from solution in acetone could reduce the vapour pressure of gamma-BHC and increase its persistence on a non-sorptive surface such as glass or aluminium. On porous surfaces,

[1] Colonial Pesticides Research Unit, Arusha, Tanganyika.
[2] Plant Protection Ltd., Fernhurst, Nr. Haslemere, Surrey, England.

such as masonite or plywood, this type of deposit failed to give the desired increase in persistence.

Bovingdon & Campbell (1957, 1958) found that a solid solution of gamma-BHC formed by melting the insecticide with a resin and allowing the mixture to cool could be powdered and converted into a water-dispersible formulation. Unlike solutions of resin with BHC in a solvent, these formulations showed an enhanced persistence of BHC on sorptive and semi-sorptive surfaces, such as plaster of Paris, plywood and fibre-board. Bovingdon & Campbell also found that Cereclor, a proprietary resin manufactured by Imperial Chemical Industries Limited, was superior to all other resins tried, including chlorinated polyphenyls. In addition to being a particularly good solvent for gamma-BHC the grade of Cereclor used was such as to give a hard, friable melt, readily formulated as a dispersible powder.

This investigation was confined to the laboratory. Field evidence was essential to determine whether or not the gamma-BHC/Cereclor formulation was in fact superior to straight gamma-BHC for malaria control. A field trial was therefore set up by the Colonial Pesticides Research Unit in April 1958, at Magugu, a small village 100 miles south of Arusha, Tanganyika. The houses were of native-type and had walls lined with three types of mud and plywood. The trial is still in progress, but after twelve months the results have proved so promising in favour of gamma-BHC/Cereclor on all surfaces that publication at this stage is thought justified.

EXPERIMENTAL METHODS

The experiments were carried out in trap huts similar to those first used by Muirhead-Thomson (1950). The huts were 8 ft (2.4 m) square with a single window 1 ft (30 cm) square on the east side into which a lobster-pot type exit trap of mosquito netting was fitted. The floors were covered with hardboard, the smooth surface of which made easier the collection of dead mosquitos on the floor. Double doors were fitted—a wooden tongue-and-groove door which was kept closed only from dusk to dawn, and a gauze door closed throughout the day to prevent both the escape of mosquitos and a possible build-up of gamma-BHC in the hut atmosphere, such as would not usually occur during the day in a native hut.

At the suggestion of Mr. R. E. Rapley, two important improvements over the huts used by Davidson and Burnett were made. The huts were raised on concrete legs one foot high with a concrete water channel cast around the base of each leg. This protected the huts very effectively against the ant invasions which seriously hampered Burnett's work. In addition, the huts were built of burnt brick, so making them more permanent than true native-type houses.

The hut walls were lined with mud or plywood, and all huts were roofed with grass thatch 6-12 in. thick supported on whole-sisal pole verticals and split-sisal pole horizontals with the pith facing into the hut.

Plywood was used as a wall surface since it was easier to handle, and had been found by Hadaway & Barlow (1958) in the laboratory to give approximately the same persistence with gamma-BHC as grass thatch, split bamboo, and similar surfaces. The three muds were obtained from Babati, Magugu, and Njoro Nkubwa. The Babati mud was believed to be highly sorptive and the other two muds to be of low sorptive capacity.

Since gamma-BHC persists normally by sorption into mud, care was taken to ensure that the mud-plaster lining the wall was at least 1 in. thick.

The huts were sprayed with Gammexane Dispersible Powder (50% gamma-BHC of lindane quality) and an experimental gamma-BHC/Cereclor dispersible powder containing 25% of gamma-BHC formulated by Plant Protection Ltd. The dosage used in all huts was approximately 0.5 g of gamma-BHC per square metre (50 mg of gamma-BHC per square foot).

The preparations were applied to the walls and roof of each hut at 30 lb. per sq. in. using an Oxford Precision Sprayer fitted with an Allman 0 nozzle. The sprayer was charged with the exact quantity of spray for each hut, an increase of 50% being made in the nozzle dosage to allow for known fallout with this machine. The floors were not protected against fallout. All surfaces were sprayed twice in an endeavour to obtain as even a deposit as possible, and in addition the rate of movement of the spray lance was kept constant by timing the action with a stop-watch. Despite these precautions, the deposit achieved was obviously uneven, although probably better than the deposits obtained in normal field applications for malaria control.

Two methods of assessment were employed: (1) window trap catches, and (2) bioassay of different surfaces in the huts.

1. *Window trap catches*

Window traps were fitted to the huts each evening at 4.30 p.m. and removed at 7.00 p.m., so catching the dusk exodus. Further traps in place from 7.00 p.m. to 7.30 a.m. caught the night and dawn exodus. The trapped mosquitos were removed to holding cages and kept with sugared water for 24 hours, after which the mortality was counted. In addition, mosquitos dead on the hut floor were collected in the morning and again in the afternoon. The sum of those dead on the floor together with those found dead and alive from the traps gave the percentage mortality in the hut.

2. *Bioassay*

The relative toxicities of the different substrates in each hut were determined by bioassay, using the standard technique recommended by the World Health Organization. Initially, only the walls were assayed, using female *A. gambiae* confined under petri-dishes. A slide device designed by Mr G. F. Poulton was used to fix the dishes to the walls.

Subsequently, assay of the thatch and the split-sisal poles was made. This necessitated using funnels enclosed in fine mosquito gauze to prevent escape of mosquitos into the thatch or along the rough grooves of the sisal pith. With both petri-dishes and funnels, mosquitos were confined on the substrates for varying periods and then transferred to holding cages for 24 hours, after which the percentage mortality was counted.

RESULTS

1. *Window traps*

The results summarized in Table 1 show that high kills were obtained initially in all huts treated, both in April and in November 1958.

In all except one hut, a mortality of female anophelines of the order of 50% was achieved for six months, both with straight gamma-BHC and with gamma-BHC/Cereclor applied to all three muds and the plywood. The exceptional hut was hut 7, which was lined with Njoro Nkubwa mud and sprayed with gamma-BHC/Cereclor. In this hut, which was sprayed in November 1958, high kills were obtained until April 1959, when three of the four walls were extensively damaged by an African.

Assessment of the results during the 6-12 months of the trial was made difficult in some cases by the small numbers of mosquitos caught. In such cases, if a high mortality was continuously obtained with small numbers of mosquitos, then in our view this represented the true figure, but where both high and low mortalities were obtained in random order, we assumed that the true figure lay somewhere between the two extremes. On this basis, gamma-BHC/Cereclor has continued to give high mortalities on both Babati and Magugu muds for 12 months, and gamma-BHC alone for 11 months.

It is of interest that the control hut attracted a larger number of mosquitos than the treated huts. This was almost certainly due to the treated huts being newly built just before they were sprayed, whereas the control hut had been inhabited for two years.

2. *Bioassay*

Tests were carried out initially only on the hut walls by confining female *A. gambiae* under 4-in. (10-cm) diameter petri-dishes. In order to test the thatch and other surfaces in the huts, a funnel with a fine net covering had to be used. A 4½-in. (11-cm) diameter funnel was used for the wall and thatch, but a 2-in. (5-cm) diameter funnel had to be employed for the narrow split-sisal poles. The different mortalities obtained with the three different containers are shown in Table 2. It is clear that the petri-dishes give a much higher mortality than either of the funnels covered with netting, and that the netting is responsible for the reduction in kill.

(*a*) *Wall tests.* All results are given in Table 3. A marked drop in mortalities with all surfaces will be noted after 11 May, when funnels were substituted for petri-dishes.

The figures for each hut are variable, as is to be expected since the deposit in each hut was not even and only small areas were sampled each time. Nevertheless when gamma-BHC and gamma-BHC/Cereclor are compared for each type of mud, the latter is always superior—often considerably so.

(*b*) *Thatch and split-sisal poles.* The results are given in Table 4. As with the mud walls, both thatch and sisal poles give high mortalities with gamma-BHC/Cereclor in almost all cases, but unlike mud, no high kills are obtained with gamma-BHC even after prolonged exposure on surfaces sprayed six months previously. This reflects the low sorptive properties of thatch and split-sisal poles. If the bioassay results for thatch and sisal are compared with the bioassay tests on plywood in Table 3, it is obvious that plywood in our experiments has proved to be a far less favourable substrate for gamma-BHC/Cereclor than thatch and split-sisal poles.

TABLE 1

SUMMARY OF MAGUGU WINDOW TRAP RESULTS: PERCENTAGE 24-HOUR MORTALITY OF *A. GAMBIAE* FEMALES

Hut No.	Substrate	Formulation*	Date applied (1958)	Total number of anophelines caught and, in parenthesis, 24-hour mortality (%)								
				April 11-30	May 1-31	June 1-30	July 1-Dec. 31	Jan. 1-31	Feb. 1-28	March 1-31	April 1-30	May 1-30
20	Babati mud	γ-BHC/resin	Nov. 26				Insufficient anophelines for assessment due to dry season	5 (100)	18 (94)	15 (80)	83 (61)	84 (75)
17	Babati mud	γ-BHC	Nov. 26					2 (100)	7 (100)	85 (81)	130 (70)	96 (66)
7	Njoro Nkubwa mud	γ-BHC/resin	Nov. 26					10 (100)	20 (75)	81 (84)	88** (30)	55 (36)
9	Njoro Nkubwa mud	γ-BHC	Nov. 26					26 (100)	99 (93)	111 (90)	166 (60)	108 (60)
19	Plywood	γ-BHC/resin	Nov. 26					18 (100)	140 (85)	406 (88)	99 (56)	69 (53)
18	Plywood	γ-BHC/resin	Nov. 26					6 (83)	14 (64)	92 (79)	162 (62)	99 (47)
12	Babati mud	γ-BHC/resin	April 10	36 (100)	28 (100)	5 (80)		4 (50)	13 (92)	11 (55)	24 (70)	33 (66)
8	Babati mud	γ-BHC	April 10	13 (100)	19 (100)	1 (100)		14 (95)	4 (50)	10 (60)	103 (21)	95 (16)
10	Magugu mud	γ-BHC/resin	April 10	18 (100)	105 (100)	9 (100)		3 (100)	50 (86)	73 (72)	129 (50)	164 (22)
11	Magugu mud	γ-BHC	April 10	25 (100)	46 (100)	5 (100)		12 (50)	12 (75)	13 (84)	81 (43)	93 (29)
1	Magugu mud	control		161 (21)	198 (2)	57 (5)		366 (13)	588 (10)	1182 (4)	412 (1)	406 (3)
	Rainfall (inches)			5.93	3.92	0.66		2.06	2.72	8.72	3.52	2.79

* Dosage 0.5 mg gamma-BHC per m^2

** Three walls damaged by African sleeping in hut

(*c*) *Other surfaces.* Other surfaces of less practical importance tested in the huts were the doors and floor. The results are shown in Table 5.

With the doors, the results are complicated by vibration during frequent closing, rubbing with clothes, and treatment with creosote a few weeks before the spray application. The results are therefore of little importance as a true assessment of the formulations, but it is of interest that in most cases gamma-BHC/Cereclor gives a high kill even after 12 months. Gamma-BHC gives some kill after six months which is more than could be expected on timber; this is possibly due to solubility in the creosote which would prevent evaporation.

The hardboard floors were not sprayed directly, but during the spraying of the hut they were not protected against fallout. Despite daily brushing of the floors, some mortality was obtained with gamma-BHC/Cereclor only.

DISCUSSION

The bioassay results on thatch and on split-sisal poles confirm the laboratory findings of Hadaway & Barlow that gamma-BHC cannot compare in length of persistence with gamma-BHC/Cereclor on low-sorptive surfaces of this type. It would not therefore be expected that the mortality given by gamma-BHC alone six months after application in houses built entirely of thatch or similar materials would be sufficient for malaria control. On the other hand, gamma-BHC/Cereclor should be satisfactory for this purpose. Furthermore, the mortality obtained after six months in our plywood lined huts with gamma-BHC/Cereclor might possibly have been higher than 50% if the huts had been lined entirely with thatch, since considerably higher kills were obtained on thatch than on plywood in the bio-assay tests.

With all muds, both gamma-BHC alone and gamma-BHC/Cereclor give a 50% kill in the window trap tests for six months after spraying, although the bioassay figures indicate that gamma-BHC/Cereclor is more active than straight gamma-BHC. These experiments showed no significant difference between the three muds.

When comparing our hut experiments with what happens in practice in a malaria control scheme, we arrived at the conclusion that the window trap results for the mud huts are possibly lower than might have been obtained in normally occupied native huts for gamma-BHC/Cereclor, and higher for gamma-BHC alone. Our reasons for this are that our experimental huts were not occupied throughout the day, and hence anophelines resting on the walls near the beds in the morning were not disturbed and induced to move into the roof space as would happen in a normal native hut. In the roof, the anophelines would be killed by gamma-BHC/Cereclor but not by straight gamma-BHC. This thesis is supported by the results in our huts. For example, there is

TABLE 2

VARIATIONS IN MORTALITY OF *A. GAMBIAE* FEMALES CONFINED UNDER FUNNELS AND UNDER PETRI-DISHES

A. Large funnels with nets and petri-dishes placed alternately and immediately adjacent to each other on the wall of hut 12

		Hut 12				Control hut	
		Funnel	Petri-dish	Funnel	Petri-dish	Funnel	Petri-dish
24-hour mortality (%) after 1-hour exposure		100	100	86	100	0	5
24-hour mortality (%) after 1/2-hour exposure	(*a*)	5	100	21	100	5	0
	(*b*)	6	100	7	100	0	0

B. Comparison of large funnels and small funnels both with nets

		Hut 12				Control hut	
		Large	Small	Large	Small	Small	Large
24-hour mortality (%) after 1-hour exposure	(*a*)	27	13	0	0	9	30
	(*b*)	14	11	0	22	0	0

C. Comparison of large funnels with and without nets

		Hut 12				Control hut	
		Net	No net	Net	No net	Net	No net
24-hour mortality (%) after 1-hour exposure	(*a*)	39	100	0	100	10	0
	(*b*)	80	100	60	100	0	10

(*a*) and (*b*) are replicate experiments carried out at different times.

TABLE 3

WHO BIOSSAY TESTS ON WALLS OF MAGUGU HUTS USING FUNNELS AND PETRI-DISHES

Hut number	Substrate	Formulation	Date applied (1958)	Replicate	Percentage 24-hour mortality of *A. gambiae* females																										
					Petri-dishes																				Funnels						
					February						March						April						May		May						
					2	5	10	12	18	26	5	11	13	18	24	26	2	7	14	21	23	28	7	8	11	12	12	13	13	14	19
					A	A	A	A	A	A	B	A	A	B	A	A	B	A	A	B	A	A	B	B	B	B	B	B	B	B	B
20	Babati mud	γ-BHC/ resin	Nov. 26	1 2	100 100			100 100					100 100			96 100			90 75			50 100	100 100					32 50			
17	Babati mud	γ-BHC	Nov. 26	1 2			100 100			78 83			100 96			93 59			70 66			18 19	100 86					17 25			
7	Njoro Nkubwa mud	γ-BHC/ resin	Nov. 26	1 2		95 82			74 65			100 100			100 82			38 76			56* 16		63* 100				5* 31				
9	Njoro Nkubwa mud	γ-BHC	Nov. 26	1 2		52 24			40 77			100 96			73 82			27 33			0 17		72 90				7 26				
19	Plywood	γBHC/ resin	Nov. 26	1 2	96 100			54 18			50 58			100 100			100 100			61 100				4 58					0 0	0 11	15 0
18	Plywood	γBHC/ resin	Nov. 26	1 2	95 100			52 60			96 100			100 64			64 43			36 61			62 0						15	9 0	5 0
12	Babati mud	γBHC/ resin	Apr. 10	1 2			95 95			100 79			100 100			100 80			96 100			68 85	100 100		100 20						
8	Babati mud	γBHC	Apr. 10	1 2		20 7			17 7		46 26			18 20			40 16			40 19			0 0		4 4						
10	Magugu mud	γ-BHC/ resin	Apr. 10	1 2		28 37			96 86			83 96			75 96			29 25			12 18		100 63			16 55					
11	Magugu mud	γ-BHC	Apr. 10	1 2			12 4			0 20	50 42			21 30			21 0			60 41			0 0			0 0					
1	Magugu mud	Control		1 2	38 77	4 5	8 0	0 16	33 25	0 0	0 5	0 14	16 7	8 4	0 5	0 0	0 8	4 0	19 10	4 10	13 4	0 0	0 0	5	0 0	0 0	0 9	5 0	9 0	0 0	0
Laboratory control **					8	3	—	6	19	0	0	0	16	0	0	0	0	0	0	—	10	—	—	0	6	—	—	—	4	—	—

A = 1/2-hour exposure. B = 1-hour exposur.

* Intact section of wall used for test. ** Mosquitos kept in cages in laboratory for duration of each bioassay test as check on natural mortality.

TABLE 4

WHO BIOASSAY TESTS ON ROOF THATCH (LARGE FUNNELS) AND SPLIT-SISAL POLES (SMALL FUNNELS) OF MAGUGU HUTS

Hut number	Substrate	Formulation	Date applied (1958)	Replicate	Percentage 24-hour mortality of *A. gambiae* females															
					Thatch													Split-sisal poles		
					April		May											May		
					29 A	30 C	4 C	5 C	5 C	6 C	11 B	12 B	12 B	13 B	13 B	14 B	19 B	20 D	21 B	21 D
20	Babati mud	γ-BHC/ resin	Nov. 26	1 2					100 100					26 60				100* 100*		
17	Babati mud	γ-BHC	Nov. 26	1 2					6 18					0 0				10 33		0 20
7	Njoro Nkubwa mud	γ-BHC/ resin	Nov. 26	1 2				74 97					30 5							
9	Njoro Nkubwa mud	γ-BHC	Nov. 26	1 2				5 17					5 0							0 0
19	Plywood	γ-BHC/ resin	Nov. 26	1 2						50 100					5 93	0 5	38 29		100 100	
18	Plywood	γ-BHC/ resin	Nov. 26	1 2						100 72					100	0 4	100 100		100 100	
12	Babati mud	γ-BHC/ resin	April 10	1 2	4 30	97 100					90 100									
8	Babati mud	γ-BHC	April 10	1 2		4 18					4 0									
10	Magugu mud	γ-BHC/ resin	April 10	1 2			10 98					20 18								
11	Magugu mud	γ-BHC	April 10	1 2			5 10					0 0								
1	Magugu mud	Control		1 2	8 5	0 0	5	8	0	11	14 0	2 2	6 4	4 5	0 9	4	0	18	0	0
		Laboratory control **			3	3	0	0	—	0	6	—	—	—	4	—	—	—	—	—

A = 1/2-hour exposure B = 1-hour exposure C = 2-hour exposure D = 3-hour exposure

* All dead in one hour

** Mosquitos kept in cages in laboratory for duration of each bioassay test as check on natural mortality

TABLE 5

WHO BIOASSAY TESTS WITH LARGE FUNNELS ON DOORS AND FLOORS OF MAGUGU HUTS

Hut number	Substrate	Formulation	Date applied (1958)	Replicate *	Percentage 24-hour mortality of *A. gambiae* females										
					Doors							Floors			
					April	May						May			
					30 B	4 B	5 B	5 B	6 B	8 B	8 B	1 B	18 A	18 A	19 A
20	Babati mud	γ-BHC/ resin	Nov. 26	1 2				65 53							14 9
17	Babati mud	γ-BHC	Nov. 26	1 2				12 38							0
7	Njoro Nkubwa mud	γ-BHC/ resin	Nov. 26	1 2			100 100						16 19		
9	Njoro Nkubwa mud	γ-BHC	Nov. 26	1 2			22 16						0 0		
19	Plywood	γ-BHC/ resin	Nov. 26	1 2					5 0	5 9					
18	Plywood	γ-BHC/ resin	Nov. 26	1 2					0 10	0 0	27 10				
12	Babati mud	γ-BHC/ resin	April 10	1 2	100 100							58 44			
8	Babati mud	γ-BHC	April 10	1 2	0 0							4 8			
10	Magugu mud	γ-BHC/ resin	April 10	1 2		38 93								5 0	
11	Magugu mud	γ-BHC	April 10	1 2		0 0								0 0	
1	Magugu mud	Control		1 2	0 0	0	4	0	12	5	5	0 0	11 0	5 5	0 0
		Laboratory control **			3	0	0		0	0	0		0	0	—

A = 1-hour exposure B = 2-hour exposure

* 20-25 individuals were used in each replicate.

** Mosquitos kept in cages in laboratory for duration of each bioassay test as check on natural mortality

little difference between huts 17 and 20 in window trap mortality after six months (see Table 1), even though the roof of hut 17, treated with straight gamma-BHC, was relatively non-toxic, while the roof of hut 20, treated with gamma-BHC/Cereclor, was highly toxic. On the other hand, the kills in experimental huts tend sometimes to be rather higher than those achieved in practice because of the presence in African houses of untreated surfaces, such as clothing, bedding and domestic equipment.

In the seventh report of the WHO Expert Committee on Malaria (World Health Organization, 1959) the statement is made that " As most houses with mud walls have roofs made of non-sorptive material, the ideal insecticide would be one that combines the fumigant properties of BHC on sorptive surfaces and the prolonged contact action of DDT or dieldrin on non-sorptive ones ". We believe that gamma-BHC/Cereclor approaches such an ideal.

ACKNOWLEDGMENTS

In the course of this work we have received valuable help from Dr L. Bruce-Chwatt and Mr J. Wright, World Health Organization, Geneva; Dr R.A.E. Galley, Colonial Pesticides Research Committee, London; Dr A. B. Hadaway and Mr F. Barlow, Colonial Pesticides Research Unit, Porton; as well as from the following members of the staff of the Colonial Pesticides Research Unit, Arusha: Dr K. C. Sleep, Dr M. A. Vickars, Mr E. T. Mesmer, Mr R. E. Rapley, Mr W. Bransby-Williams, Mr J. Hudleston, and Mr G. F. Poulton, to all of whom we should like to express our gratitude. We should also like to thank our African assistants, and particularly Mr Wilson Okan, for the extremely careful and conscientious way in which they carried out their work.

RÉSUMÉ

Pour être efficace, la lutte contre *Anopheles gambiae* par le HCH doit assurer la destruction de 50%-60% des femelles pénétrant dans les maisons, pendant au moins 6 mois, quel que soit le matériau utilisé pour le revêtement intérieur des habitations. Le HCH simple ne remplit pas cette condition. On sait depuis plusieurs années que l'addition d'une résine (polyvinyl chloré par exemple) réduit l'évaporation du HCH et accroît sa rémanence sur les surfaces non sorbantes, telles que le verre ou l'aluminium, mais non sur les surfaces sorbantes, telles que les boues ou les revêtements végétaux. Une nouvelle forme de préparation de HCH, assurant la persistance sur les matériaux poreux a été récemment mise au point: la résine est fondue avec l'insecticide, puis la masse refroidie est pulvérisée et mise en suspension dans l'eau. La résine Cereclor, qui a donné les meilleurs résultats en laboratoire, a été mise à l'étude dans les conditions de la pratique, par l'Institut de recherches d'Arusha (Tanganyika) dans un village des environs de cette ville. La méthode paraissant prometteuse, les auteurs publient dans cet article leurs premiers résultats, après 12 mois d'observation. Ils décrivent la technique appliquée (par trappes et bio-essais) dans des huttes expérimentales à l'épreuve des fourmis, revêtues de boue séchée ou de bois et couvertes de chaume. Ils relèvent les différences, pouvant affecter les résultats, entre les huttes expérimentales et celles qui sont normalement habitées: dans les premières, les anophèles sont moins dérangés par la présence humaine et, de ce fait, ont moins de chances de contact avec l'insecticide; dans les secondes, ils trouvent des recoins non traités où s'abriter (lits, ustensiles de ménage, etc.). Compte tenu de cette approximation, les résultats indiquent que le HCH/Cereclor est plus actif que le HCH simple. Les auteurs concluent que cette préparation tend à satisfaire à la définition de l'insecticide idéal, telle qu'elle est formulée dans le septième rapport du Comité d'experts du Paludisme: « ... celui qui aurait à la fois les propriétés fumigantes de l'HCH sur les surfaces sorbantes et l'action de contact prolongée du DDT ou de la dieldrine sur les surfaces non sorbantes. »

REFERENCES

Armstrong, J.A. (1958) *Bull. Wld Hlth Org.*, **19**, 1105

Bovingdon, H. H. S. & Campbell, A. (1957) Brit. Pat. Applications Nos. 37459/57 & 37550-57, filed 2.12.57

Bovingdon, H. H. S. & Campbell, A. (1958) Belgian Pat. No. 573482, filed 1.12.58

Burnett, G. F. (1957) *Bull. ent. Res.*, **48**, 631

Davidson, G. (1953), *Bull. ent. Res.*, **44**, 231

Hadaway, A. B. & Barlow, F. (1952) *Bull. ent. Res.*, **43**, 281

Hadaway, A. B. & Barlow, F. (1958) *The residual toxicity to mosquitos of insecticide deposits on various building materials* (Colonial Insecticides Research Unit, Porton, Report No. 155)

Hornstein, I. & Sullivan, W. N. (1953) *J. econ. Ent.*, **46**, 937

Macdonald, G. & Davidson, G. (1953) *Bull. Wld Hlth Org.*, **9**, 785

Muirhead-Thomson, R. C. (1950) *Trans. roy. Soc. trop. Med. Hyg.*, **43**, 401

World Health Organization (1959) *Wld Hlth Org. techn. Rep. Ser.*, **162**, 35