Delfini was semi-immune and resided in a rural holoendemic environment. The schoolchildren reporting at the 2 clinics where the present study was made reside in the city of Lagos or its suburbs. It would appear that many of these latter children did not have a protective immunity at the time they developed their malarial infections, which probably accounted for the high density of parasitaemia and for the pyrexia recorded in them. That the children living in Lagos may not be as immune to malaria as their rural counterparts has been pointed out by Fasan,[c] who recorded a much higher average parasite density in a group of infected urban Lagos schoolchildren than in a comparable group of children in the rural part of Lagos State. Hendrickse [h] recorded a similar impression in relation to children seen in the University College Hospital, Ibadan, Western Nigeria. The lowering of the immunological protection in these children may be related to irregularly administered or discontinued chemoprophylaxis for malaria, and also to a reduced contact with mosquitos.

[h] Hendrickse, R. G. (1969) *Enf. Milieu trop.*, No. 53, p. 3

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A Village-scale Trial of OMS-214 (Dicapthon) for the Control of *Anopheles gambiae* and *Anopheles funestus* in Northern Nigeria

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Trial area

The WHO *Anopheles* Control Research Unit No. 1 carried out a village-scale field trial of OMS-214 [b] to assess the residual effectiveness of this compound against the local malaria vectors *An. gambiae* and *An. funestus* during 1968. The trial area lies in the Kujama District of Zaria Province in the North Central State in Northern Nigeria. This area comprises 4 villages (Riddo Hausa, Riddo Leman, Riddo Hayi and Riddo Gwari) and is 15 miles (24 km) away from Kaduna towards the south-east. The 4 villages are located at varying distances from each other within a linear distance of 1½ miles (2.4 km) in the midst of the Guinea savanna bush with a patch of clearance of 3 mi²–4 mi² (7 km²–10 km²) for cultivation. The land is fairly flat and is traversed by a small perennial stream flowing from north to south. This stream joins a nearby river flowing from east to west. Environmental conditions and topographical features typical of the Guinea savanna area and the description of villages prevalent in and around Kaduna have been given by Hannay [c] and Service.[d]

Spraying operations

Insecticide. Three drums of OMS-214 water-dispersible powder were received in March 1968 for these trials. Representative samples of these were tested in the unit's laboratories for their physical

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[b] Dicapthon: *O*-2-chloro 4-4-nitrophenyl *O,O*-dimethyl phosphorothioate.

[c] Hannay, P. (1960) *Bull. ent. Res.*, **51**, 45.

[d] Service, M. (1963) *Bull. ent. Res.*, **54**, 601.

TABLE 1
EFFECT OF OMS-214 ON DENSITIES OF *AN. GAMBIAE* AND *AN. FUNESTUS* FEMALES

Days after spray	*An. gambiae*		*An. funestus*	
	Average hut densities (pyrethrum-spray and exit-trap catches combined)[a]	Reduction (%) in density in relation to control	Average hut densities (pyrethrum-spray and exit-trap catches combined)[a]	Reduction (%) in density in relation to control
Pre-spray	7.4 (9.5)	—	11.3 (10.7)	—
Pre-spray	15.1 (15.4)	—	46.5 (67.5)	—
1	0 (1.8)	100	0.1 (36.0)	99.7
15	0 (6.3)	100	0.2 (95.8)	99.7
29	0.4 (16.3)	97.5	0.2 (65.0)	99.6
43	0.3 (8.1)	96.3	0.4 (73.1)	99.4
57	1.4 (8.3)	77.6	1.1 (75.8)	98.5
71	6.7 (11.9)	43.8	3.4 (102.5)	96.6
85	2.3 (8.7)	73.5	3.4 (66.6)	94.8
99	5.3 (18.2)	70.9	12.4 (146.3)	91.4
113	8.1 (23.2)	65.1	5.8 (104.2)	94.4
127	2.0 (7.1)	71.8	4.8 (100.8)	95.2
140	3.1 (4.6)	32.6	10.9 (198.2)	91.4

[a] Figures in parentheses are for the unsprayed control village.

and chemical properties according to the WHO Interim Specifications. The contents of all the drums had good free-flowing properties and showed no deterioration on accelerated storage. The samples conformed to standards laid down in the WHO Interim Specification for OMS-214 water-dispersible powder.

Field application. Spraying was carried out by the end of May 1968 in the villages of Riddo Hausa, Riddo Leman and Riddo Hayi for 3 consecutive days by 4 spraymen and 1 mixer. A total of 219 inhabited huts and 262 other structures were sprayed, using 102 kg of the 50% water-dispersible powder.

The formulation went into suspension readily with little stirring and no significant nozzle-tip erosion was observed after spraying about 100 pump charges. The final calculated dosage achieved was 2.27 g/m². The total population in the sprayed area was 453.

Toxicology. Toxicological observations were made by the WHO toxicologist during the spraying operations.[e] No complaints attributable to OMS-214 were recorded among the operators or the villagers living in the sprayed villages.

Entomological assessment

Entomological assessments as stated below were routinely conducted in the sprayed village, Riddo Hausa, every 15 days. For comparison, the unsprayed village, Riddo Gwari, about 1½ miles (2.4 km) to the east of Riddo Hausa was visited routinely once a fortnight.

Methods. The hut-resting densities of mosquitos were measured between 7 a.m. and 10 a.m. by pyrethrum spray (0.2% concentration) in 10 catching stations. The mosquitos were classified according to species, sex and abdominal stages.

[e] Vandekar, M. & Wilford, K.: unpublished working document WHO/VBC/68.99. A limited number of copies of this document is available to persons officially or professionally interested on request to Distribution and Sales, World Health Organization, 1211 Geneva, Switzerland.

TABLE 2

ABDOMINAL CONDITION OF *AN. GAMBIAE* COLLECTED BY PYRETHRUM-SPRAY AND EXIT-TRAP CATCHES OF FED AND GRAVIDS TRAPPED IN OMS-214 SPRAYED AREA

Days after spray [a]	Pyrethrum-spray catches [b]						Exit-trap catches			
	Sprayed village			Unsprayed village			Sprayed village		Unsprayed village	
	No. of females	% fed	% gravid	No. of females	% fed	% gravid	No. of females	No. fed and gravid	No. of females	No. fed and gravid
Pre-spray	52	80.7	19.2	33	72.7	27.2	22	7	62	27
Pre-spray	85	64.7	31.7	73	45.2	53.4	66	39	81	45
1	0	0	0	10	(10)	0	0	0	8	3
15	0	0	0	42	85.7	14.2	0	0	21	11
29	0	0	0	128	77.3	22.6	4	2	35	21
43	0	0	0	58	68.9	22.4	3	0	23	9
57	1	(1)	0	47	76.6	23.4	13	0	16	9
71	13	(10)	(2)	90	92.2	5.5	54	33	29	15
85	3	(3)	0	41	90.2	7.3	20	9	46	34
99	6	(6)	0	113	86.7	10.6	47	37	69	35
113	14	(10)	(4)	143	79.7	17.4	67	61	89	53
127	6	(4)	(1)	43	90.7	2.3	14	8	28	23
140	22	63.6	27.2	29	82.7	10.3	9	3	17	3

[a] Days on which tests were done in the unsprayed village do not always correspond exactly to those shown for the sprayed village under " Days after spray ", but the period covered is the same and the difference is seldom more than 1 day.

[b] Figures in parentheses indicate the *number* fed or gravid, where the totals are too small to allow of valid calculation of percentages.

Door exit-traps, made of mosquito netting on a wire-frame exit trap sewn to a heavy cloth, were used to determine the numbers of anophelines leaving the huts. The traps were fixed to the huts in the evening and were removed next morning before the pyrethrum-spray catch. The mosquitos were differentiated according to species, sex and abdominal stage and the 24-hour survival rate was also noted.

Night biting rates were determined by making all-night biting catches, from 7 p.m. to 6 a.m., in the sprayed village with parallel biting catches in the unsprayed village on the same night for comparison. A team of 2 bait-collectors was posted inside each hut; they collected mosquitos from each other and from their own exposed limbs. Six to 8 bait-collectors were used in the sprayed village and 6 bait-collectors in the unsprayed control village. The mosquitos were identified the next day and were also dissected to distinguish the parous from the nulliparous, using the technique of Detinova or Polovodova depending on the stage of development of ovaries.

Bioassay tests were conducted every 15 days by the technique recommended by the WHO Expert Committee on Insecticides,[f] using laboratory-bred *An. gambiae* and wild-caught *An. funestus*. Selection of points at which to fix cones on the sprayed surfaces for bioassays was done according to the method described by Pant & Self.[g]

[f] WHO Expert Committee on Insecticides (1963) *Wld Hlth Org. techn. Rep. Ser.*, **265**, 139.

[g] Pant, C. P. & Self, L. S. (1966) *Bull. Wld Hlth Org.*, **35**, 709.

TABLE 3

ABDOMINAL CONDITION OF *AN. FUNESTUS* COLLECTED BY PYRETHRUM-SPRAY AND EXIT-TRAP CATCHES OF FED AND GRAVIDS TRAPPED IN OMS-214 SPRAYED AREA

Days after spray [a]	Pyrethrum-spray catches [b]						Exit-trap catches			
	Sprayed village			Unsprayed village			Sprayed village		Unsprayed village	
	No. of females	% fed	% gravid	No. of females	% fed	% gravid	No. of females	No. fed and gravid	No. of females	No. fed and gravid
Pre-spray	84	59.5	40.4	60	55.0	43.3	29	22	47	38
Pre-spray	248	65.7	33.8	337	57.9	39.1	217	134	338	195
1	0	0	0	235	80.0	19.1	1	0	125	87
15	1	(1)	0	580	61.7	37.0	1	1	378	262
29	0	0	0	525	75.8	21.7	2	1	125	55
43	1	0	0	518	54.4	43.4	3	2	213	142
57	3	(1)	(1)	536	60.4	36.0	8	4	222	138
71	4	(2)	0	722	77.0	22.0	30	12	303	209
85	15	93.3	0	385	64.1	31.4	19	2	281	204
99	25	88.0	4.0	816	66.3	25.9	99	50	647	472
113	26	69.2	26.9	695	60.2	37.1	32	20	347	268
127	10	(8)	(2)	628	63.7	32.4	38	26	380	283
140	72	52.7	38.9	1 209	49.2	17.2	37	27	773	574

[a] Days on which tests were done in the unsprayed village do not always correspond to those shown for the sprayed village under " Days after spray ", but the period covered is the same and the difference is seldom more than 1 day.

[b] Figures in parentheses indicate the *number* fed or gravid, where the totals are too small to allow of valid calculation of percentages.

Results and discussion

The densities of *An. gambiae* and *An. funestus* as measured by the pyrethrum-spray and exit-trap catches in the sprayed and check villages are given in Table 1. It may be seen that the densities of these 2 species were quite low up to 43 days in the sprayed village. On the 57th day after spraying the combined density of the 2 species was 2.5 per hut. By 71 days after spraying it went up to 10.1 per hut. That of *An. funestus*, however, remained below 10% of the control figure throughout.

Data relating to the abdominal stages are shown in Tables 2 and 3. The number of fed and gravid also increased following the rise in density in the sprayed village.

As may be seen from Table 4, the biting rates of *An. gambiae* and *An. funestus* were very low up to

TABLE 4

EFFECT OF OMS-214 SPRAY ON THE NIGHT-BITING RATES OF *AN. GAMBIAE* AND *AN. FUNESTUS*

Days after spray	No. of baits	Density per bait [a]	
		An. gambiae	*An. funestus*
8	6 (6)	1.3 (6.5)	0.66 (19.0)
22	6 (6)	4.8 (8.0)	1.3 (12.3)
36	8 (6)	3.7 (10.0)	2.7 (28.3)
50	8 (6)	2.2 (4.5)	3.1 (11.5)
63	8 (–)	5.5 (–)	4.3 (–)
78	8 (6)	4.7 (14.5)	4.3 (45.6)

[a] Figures in parentheses are for the unsprayed control village.

TABLE 5

24-HOUR PERCENTAGE MORTALITIES OF LABORATORY-BRED AND FED *AN. GAMBIAE* AND WILD-CAUGHT FED AND GRAVID *AN. FUNESTUS* EXPOSED FOR 30 MINUTES ON OMS-214 SPRAYED SURFACES IN VILLAGE HUTS

Days after spray	*An. gambiae*			*An. funestus*			Temperature and relative humidity during exposure
	Mud walls	Thatched roofs	Control	Mud walls	Thatched roofs	Control	
3	69.6	100	0	72.0 [a]	100	12.5	27.2°C; 81%
17	45.4	100	0	41.7 [a]	100	14.2	23.3°C; 84%
31	21.2	86.5	0	17.0	95.0	0	23.3°C; 96%
45	18.0	89.7	5.0	8.9	84.0	0	26.7°C; 83%
59	26.3 [a]	53.3 [a]	10.0	0	55.5	0	25.6°C; 92%
73	20.5	43.2	0	14.3	17.9	0	26.1°C; 82%
87	14.5	2.5	4.95	5.7 [a]	5.3	11.1	23.3°C; 87%

[a] Corrected.

8 days after spraying. The biting rates for the 2 species increased to 6.1 per bait in the sprayed village by 22 days after spraying as compared with 20.3 per bait in the control village, and this was maintained more or less at the same level up to 50 days after spraying.

The proportion of parous *An. gambiae* and *An. funestus* was found to be low up to 22 days after spraying. On the 36th day after spraying the proportion parous were high for both species.

According to results of bioassay tests which are shown in Table 5, a rapid loss of potency on mud walls was observed, as the mortality was less than 50% within 20 days after spraying. On thatched surfaces mortalities above 70% were obtained up to 45 days after spraying. Mortalities above 50% were recorded on thatch up to 59 days after spraying and thereafter further decline in mortalities was noted.

We may conclude from the entomological assessments that, 6 weeks after spraying, OMS-214 had lost some of its effectiveness against both *An. gambiae* and *An. funestus* but that it continued to exert a considerable influence, particularly against *A. funestus*, for at least 2–3 months.

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