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INSECTICIDE RESISTANCE IN ANOPHELES GAMBIAE IN LIBERIA -
SUMMARY OF RESULTS OF A FIELD SURVEY

by

C. D. Ramsdale
WHO Entomologist

The investigations on the resistance problem of Anopheles gambiae were carried out in the joint WHO/UNICEF Pilot Project at Kpain, Liberia during October-November 1957, shortly after the end of the wet season. Screen temperatures during the period varied between a minimum of 70°F and a maximum of 93°F, the lowest relative humidity recorded being 60 per cent.

Dieldrin was the insecticide used in the project and certain zones had a history of either BHC or DDT treatment. For susceptibility tests either the method of Busvine and Nash (1953) or the modified WHO method was used. Adult mosquitos used in the tests were caught resting in houses by day, or bred from wild caught larvae or from eggs laid by captured females.

The density of A. gambiae at the time of the observation was low due to the seasonal decline of the mosquito population. This unfortunate circumstance caused rather small size experiments.

Papers impregnated with a solution of dieldrin at 0.4 per cent. which kills susceptible A. gambiae only, and of 4.0 per cent. which kills susceptible and hybrids but not homozygous resistants, were the discriminating dosages used with the WHO kit. A. gambiae collected from houses in different places in the Project Area were exposed to these separating dosages. As Table I shows, the only appreciable mortality was in mosquitos from Gbedi. As the tests could not be done on the spot, but at the central laboratory, some of the mortality is probably due to the transport of samples prior to exposure.

To make sure that the lack of susceptible mosquitos found resting in houses was not caused by a "pre-catch selection" due to the action of the insecticidal wall deposits, adults bred from larvae collected at Kpain were exposed to 4.0 per cent. dieldrin (Table II). This precluded the possibility of any selective mortality due to transport of mosquitos over long distances.

Offspring of wild caught resistant females (i.e. females that had survived exposure to 4.0 per cent. dieldrin) were bred through to the adult stage and exposed to 4.0 per cent. dieldrin (Table II). That they bred true for resistance is further proof that the A. gambiae population in the Project Area is largely composed of homozygous resistant individuals.

The extremely high degree of resistance seems to have built up without severe selection pressure, as many structures throughout the area were unsprayed. At Gbedi where over 80 per cent. of the A. gambiae population was homozygous for the resistant gene, the whole village was untreated, though it is within the Project Area.

Exposing A. gambiae adults bred from larvae collected at Kpain to 0.04 per cent. gamma BHC gave an almost complete survival (actual mortality was 4 per cent. out of 56 adults tested). This shows that, similarly to Northern Nigeria, there is resistance to BHC as well as to dieldrin.

Investigating the susceptibility level of local A. gambiae to DDT, it was found that the LC_{50} was 1.1 per cent. The tested females were either wild caught or bred from larvae exposed to DDT for one hour and the mortality was read 24 hours later.

The LC_{50} of 1.1 per cent. for DDT is higher than that obtained under laboratory conditions for both the susceptible and dieldrin resistant Nigerian strains (Davidson, 1956) but is not higher than that reported from field tests in either Northern Nigeria (Armstrong, G. A., Ramakrishna, V. & Ramsdale, C. D., unpublished working document WHO/Mal/182, WHO/Insecticides/52) or the Belgian Congo (unpublished working document WHO/Mal/189) where DDT is apparently achieving control. It appears that susceptibility to DDT of A. gambiae in Kpain is normal.

Where control is being achieved the mosquito population will contain a predominance of young females and the proportion of females who live long enough to become infective will be extremely low. Table III records a pregravid rate of only 10 per cent. No observations have been made in Liberia to determine how many blood meals are necessary for completion of the first gonotrophic cycle. If, as is possible, some females require only one blood meal, the pregravid rate will not be a true reflection of the proportion of young newly emerged females in the population. There can, however, be no doubt as the sporozoite rate shows that at least 12 per cent. of the population had lived long enough to become infective and that spraying operations were not achieving any appreciable measure of control either of A. gambiae or of malaria.

If the pregravid rate does measure the size of the newly emerged part of the population with any degree of accuracy, the results recorded in Table III fit well into the pattern to be expected in an untreated area where the population is declining as a result of the onset of the dry season but not as a result of successful control.

Resistance in A. gambiae was not detected in either the Harbel or the Voinjama areas of Liberia, but mosquitos were scarce and very few were tested.

A visit to the Voinjama district confirmed that ecological conditions similar to those obtaining in Northern Nigeria or the Upper Volta Province of French West Africa, where dieldrin resistant A. gambiae have previously been detected, do not occur in Liberia, even in the most northerly part of the country.

TABLE I. A. gambiae FEMALES FROM HOUSES IN DIFFERENT PARTS OF THE WHO/UNICEF PROJECT, EXPOSED TO 0.4% AND 4.0% DIELDRIN (IN RISELLA OIL) FOR ONE HOUR^{1,2}

Locality	Actual mortalities		
	dieldrin 0.4%	dieldrin 4.0%	Check
Kpain area	3.5 (56)	3.5 (112)	0 (39)
Bahn area	-	0.0 (43)	0 (10)
Tapita	-	0.0 (49)	0 (10)
Gbedi	18.0 (192)	16.0 (56)	9 (66)

TABLE II. A. gambiae ADULTS (MALE AND FEMALE) REARED IN THE LABORATORY AT KPAIN AND EXPOSED TO 4.0% DIELDRIN (IN RISELLA OIL) FOR ONE HOUR WHEN 1-3 DAYS OLD AND FED ON SUGAR ONLY^{1,2}

	Actual mortality	
	males	females
Adults bred from larvae collected at Kpain	4 (147)	1 (75)
Adults bred from eggs laid by resistant females	4 (120)	1 (143)

TABLE III. PRE-GRAVID AND SPOROZOITE RATES

Locality	Ovaries		Pre-gravid rate	Salivary glands		Sporozoite rate
	Total	Pre-gravid		Total	Sporozoite positive	
Bahn area	92	10	11	82	17	20
Graie area	13	2	15	13	1	8
Tapita	141	8	6	116	12	10
Behaye	79	10	12	73	5	7
Total	325	30	9	284	35	12

¹ Mortalities read 24 hours later

² Figures in parentheses show numbers tested

