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The Secretary of the Expert Committee on Malaria  
has the honour to communicate hereunder  
the following note:

EXTENSION TO OTHER INSECTICIDES OF THE RESISTANCE TO DDT  
OBSERVED IN ANOPHELES SACHAROVI

by

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From observations made in Greece in 1951(1)(2)(3), it appears that, after a five year nation-wide malaria control programme carried out with the use of DDT, there were indications that A. sacharovi developed a certain degree of resistance to this insecticide.

Later observations (4)(5), and especially those made in Scala-Laonia area(6) in the summer of 1952, confirmed fully the above phenomenon, and as revealed by laboratory contact made concurrently(6), the resistance developed by the local vector was also extended to Gammexane. Concurrently a 100 per cent mortality was observed among A. sacharovi, from the same area, placed in contact with chlordane and dieldrin under laboratory conditions.

With special regard to chlordane, which gave in the past satisfactory results (7) against DDT-resistant Musca domestica(8), it should be noted that 4,071 A. sacharovi, placed for 30 minutes into contact with sprayed cages (at the rate of 150 mg per sq.m), kept in the laboratory, were all killed within the first 24 hours and this lethal action extended for a period of 40 days, at least, after spraying.

During the same period, it was decided, for practical purposes, to investigate whether the efficiency of chlordane against the local vector remains steady under outdoor conditions.

For this purpose, the village of Leimona of the same area, located near the outfall of river Evrotas, was selected. This village has a population of 834 and

is surrounded by extensive rice field and cotton plantation.

#### Malaria conditions in the area

Anopheline density in the area has always been high. During the pre-DDT period, malaria incidence in the area (13 villages, population 7,180) was high, and the school age endemo-epidemiological indices collected annually in the neighbouring village of Scala (considered as representative of the whole area) reached high rates (Table I).

The rates collected, during recent years, from school students and a limited number of infants of the same village and the village of Leimona, show a complete decline.

Anopheline density of the village of Leimona during the 1952 malaria season, when the chlordane spray was carried out, was very high, reaching a peak two days prior to the spray (12 July, four premises, male 412, female 4,542).

The village of Leimona had been sprayed with DDT ( $1.8 \text{ g/m}^2$ ) for five successive years (1946-50), but no spraying was done in 1951.

#### Observations in the village of Leimona

During the 14-17 July 1952, period and while the anopheline population in the village was high, all houses and stables in the village (430 premises in all) were sprayed with emulsified chlordane 74% at 1.5 g per sq.m of surface.

Three stables in the village were left unsprayed to serve as control stations.

As control stations were also used other stables in the neighbouring village of Souli, located seven kilometres away in the same area.

From 22 July, i.e. five days after the chlordane spray, catches of mosquitos were started (a) in sprayed premises of the village of Leimona, (b) in unsprayed premises of the same village and (c) in premises of the unsprayed neighbouring village of Souli.

These daily catches were made long after sunrise (two to three hours) in bedrooms and stables of the village of Leimona (at the average rate of two bedrooms to one stable and up to a number of anophelines, sufficient for further observations.

The anophelines caught were transferred to unsprayed premises and were placed separately in clean screen cages  $0.40 \times 0.40 \times 0.40 \text{ m}$ , kept under suitable environmental conditions.

Every morning and for three 24-hour periods after their caging, the dead mosquitos were counted.

### Results

The results obtained are as follows:

- (a) 4,774 A. sacharovi, of which 507 males and 4,267 females, caught two to three hours after sunrise within bedrooms and stables sprayed with chlordane 74% (1.5 g/m<sup>2</sup>), survived in clean cages for 24 hours 63.9% - 89.4%, for 48 hours 40.3% - 80.7% and for 72 hours 13.3% - 66.6%.
- (b) 5,032 A. sacharovi, of which 341 males and 4,691 females, caught within unsprayed stables of the same village, survived in clean cages for 24 hours 86.3% - 97.4%, for 48 hours 60.6% - 94.9% and for 72 hours 40.7% - 82.1%.
- (c) 6,102 A. sacharovi, of which 156 males and 946 females, caught within stables of the unsprayed neighbouring village of Souli, survived in clean cages for 24 hours 95.4% - 98.1%, for 48 hours, 81.6% - 92.0% and for 72 hours 60.5% - 84.0%.
- (d) The survival rate of A. sacharovi, caught within premises sprayed with chlordane, became, for the most part, higher as the time between the capture date and the day of the spraying of the village gets more distant. The survival rate, in all cases, is considerably higher among females.
- (e) The above-mentioned considerable survival rate of A. sacharovi, caught within premises sprayed with chlordane, was noted from the first catches, i.e. from the fifth day after spraying, at practically the same rate.

### Conclusions

The chlordane 74% residual spray, made for the first time in 1952 in the village of Leimona of Scala-Laconia area, which for five successive years, since 1946, had been sprayed with DDT, had but little effect on A. sacharovi.

The observed rate of survival of the mosquitoes caught with chlordane-sprayed premises was nearly the same as that noted among mosquitos, caught within unsprayed

premises of the same village and premises of the unsprayed village of Souli.

These observations, being in complete contrast to previous ones, made in Greece during the 1946-50 period with the same insecticide, indicate that the resistance to DDT, developed by the local vector, was extended to chlordane, probably in a lower degree, that seems to justify the contrary results, obtained with the same insecticide under laboratory conditions.

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Table I

SPLEEN AND PARASITE RATES AMONG SCHOOLCHILDREN AND  
SOME INFANTS IN SCALA-LACONIA, 1933-1951

Year	Spleen survey of schoolchildren examined		Parasite survey of schoolchildren and infants examined			
		%	examined	%	examined	%
1933	99	80	99	38		
1934	95	89	95	58		
1935	94	89	94	64		
1936	100	77	100	34		
1937	84	63	84	25		
1938	100	83	98	54		
1945			25	8		
1946		32	100	0	9	0
1948			93	0		
1949		11	100	0		
1950			100	0		
1951			205	0		

Table II

SPLEEN AND PARASITE RATES AMONG SCHOOLCHILDREN AND  
SOME INFANTS IN LEIMONA-LACONIA, 1949-1952

Year	Spleen survey of schoolchildren examined		Parasite survey of schoolchildren and infants examined			
		%	examined	%	examined	%
1949	48	14.5	47	0		
1950			62	0		
1951			73	0	7	0
1952						

Table III  
SURVIVAL RATES OF A. SACHAROV CAUGHT IN PREMISES  
OF THE VILLAGE OF LEIMONA, SPRAYED WITH CHLORDANE 74% (1.5 G/M<sup>2</sup>)

Observation Period	Days after Spray	No. of Tests	Number of Caged		Average % of Surviving <u>A. Sacharovi</u>									
			Mal.	Fem.	Mal.	Fem.	Tot.	After 24 Hours	After 48 Hours	After 72 Hours				
22-31.7.	5-15	10	141	944	1,085	31.9	76.4	70.6	12.7	55.0	49.5	3.5	26.6	23.6
1-10.8	16-25	10	192	1,246	1,438	17.7	71.1	63.9	7.8	45.3	40.3	3.6	14.8	13.3
11-20.8	26-35	10	77	685	762	46.7	75.3	72.4	19.4	57.6	53.8	6.4	39.5	36.2
21-30.8	36-45	10	70	866	936	68.5	91.1	89.4	41.4	83.9	80.7	34.2	69.2	66.6
31- 9.8	46-55	10	27	526	553	29.6	88.7	85.8	18.5	71.4	68.8	14.8	53.8	51.8

Table IV  
SURVIVAL RATES OF A. SACHAROV CAUGHT IN UNSPRAYED  
PREMISES OF LEIMONA

Observation Period	No. of Tests	Number of Caged		Average % of Surviving <u>A. Sacharovi</u>									
		Mal.	Fem.	Mal.	Fem.	Tot.	After 24 Hours	After 48 Hours	After 72 Hours				
22-31.7	10	142	940	1,082	67.6	89.1	86.3	18.3	67.0	60.6	7.7	46.7	41.6
1-10.8	10	101	1,483	1,584	58.4	97.9	95.3	25.7	81.5	78.0	5.9	43.1	40.7
11-20.8	10	37	815	852	91.9	96.0	95.7	64.8	87.7	86.7	48.6	77.9	76.6
21-30.8	10	38	969	1,007	84.2	97.9	97.4	71.0	95.8	94.9	60.5	82.9	82.1
31- 9.9	10	23	484	507	78.2	95.8	95.0	30.4	80.9	78.6	21.7	66.5	64.4

Table V

SURVIVAL RATES OF A. SACHAROVII CAUGHT IN PREMISES  
OF THE UNSPRAYED VILLAGE OF SOULI

Observation Period	No. of Tests	Number of Caged			Average % of Surviving A. Sacharovi								
		Mal.	Fem.	Total	After 24 Hours		After 48 Hours		After 72 Hours				
					Mal.	Fem.	Mal.	Fem.	Mal.	Fem.	Total		
22-31.7	10	61	1,318	1,379	77.0	96.8	96.0	63.5	78.8	81.6	44.2	64.6	63.7
1-10.8	10	24	1,187	1,211	83.3	98.6	98.3	70.8	90.1	89.7	54.1	77.5	77.1
11-20.8	19	12	1,143	1,155	75.0	95.7	95.4	50.0	78.8	78.5	25.0	60.8	60.5
21-30.8	10	29	1,099	1,128	58.6	97.4	96.4	43.3	91.9	90.6	37.9	78.2	77.2
31- 9.9	10	30	1,199	1,229	46.6	97.0	95.8	33.3	83.9	82.7	20.0	62.8	61.7

FIG. 1

FIRST 24 HOURS PERIOD  
PREMIERE PERIODE DE 24 HEURES

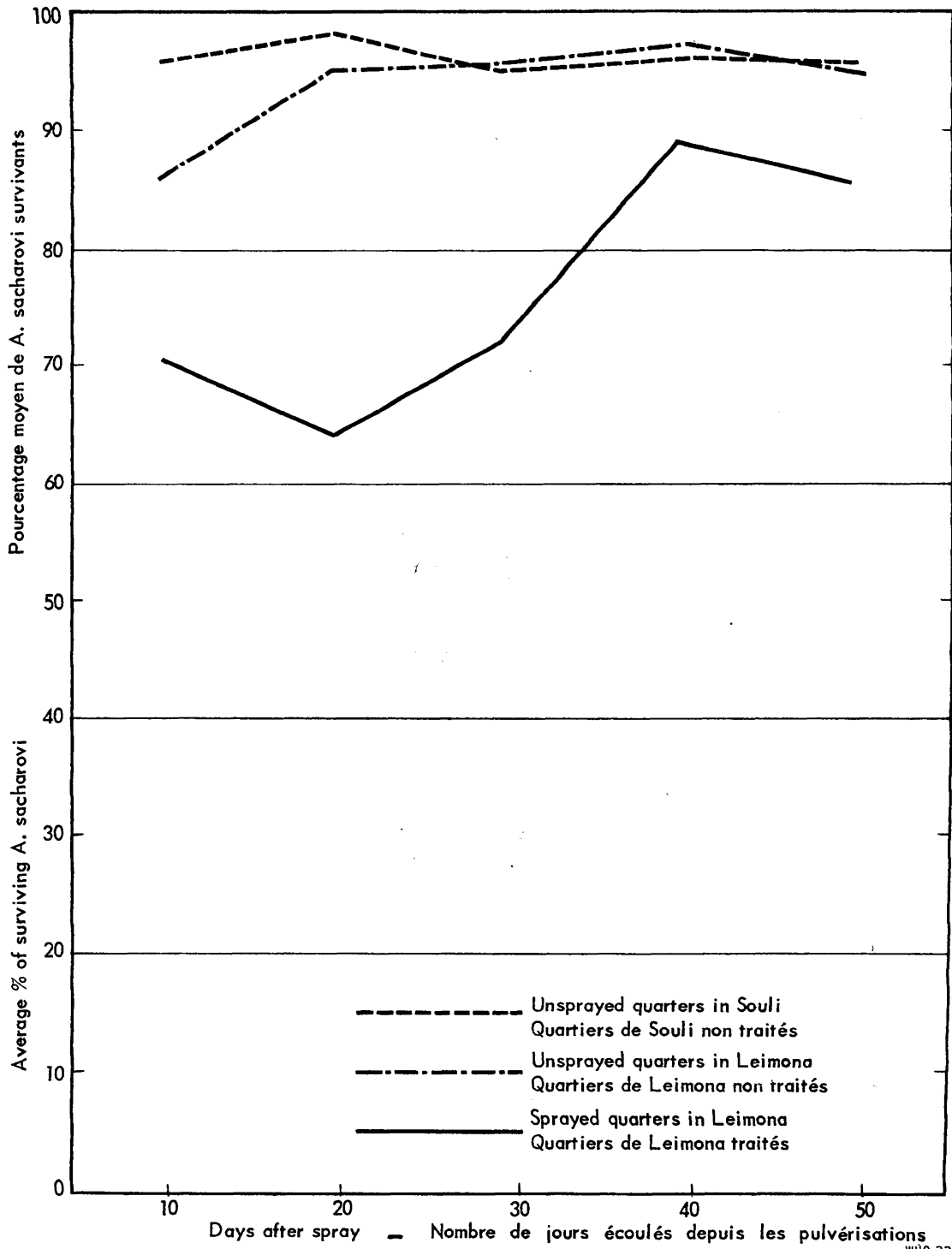


FIG. 2

SECOND 24 HOURS PERIOD  
DEUXIEME PERIODE DE 24 HEURES

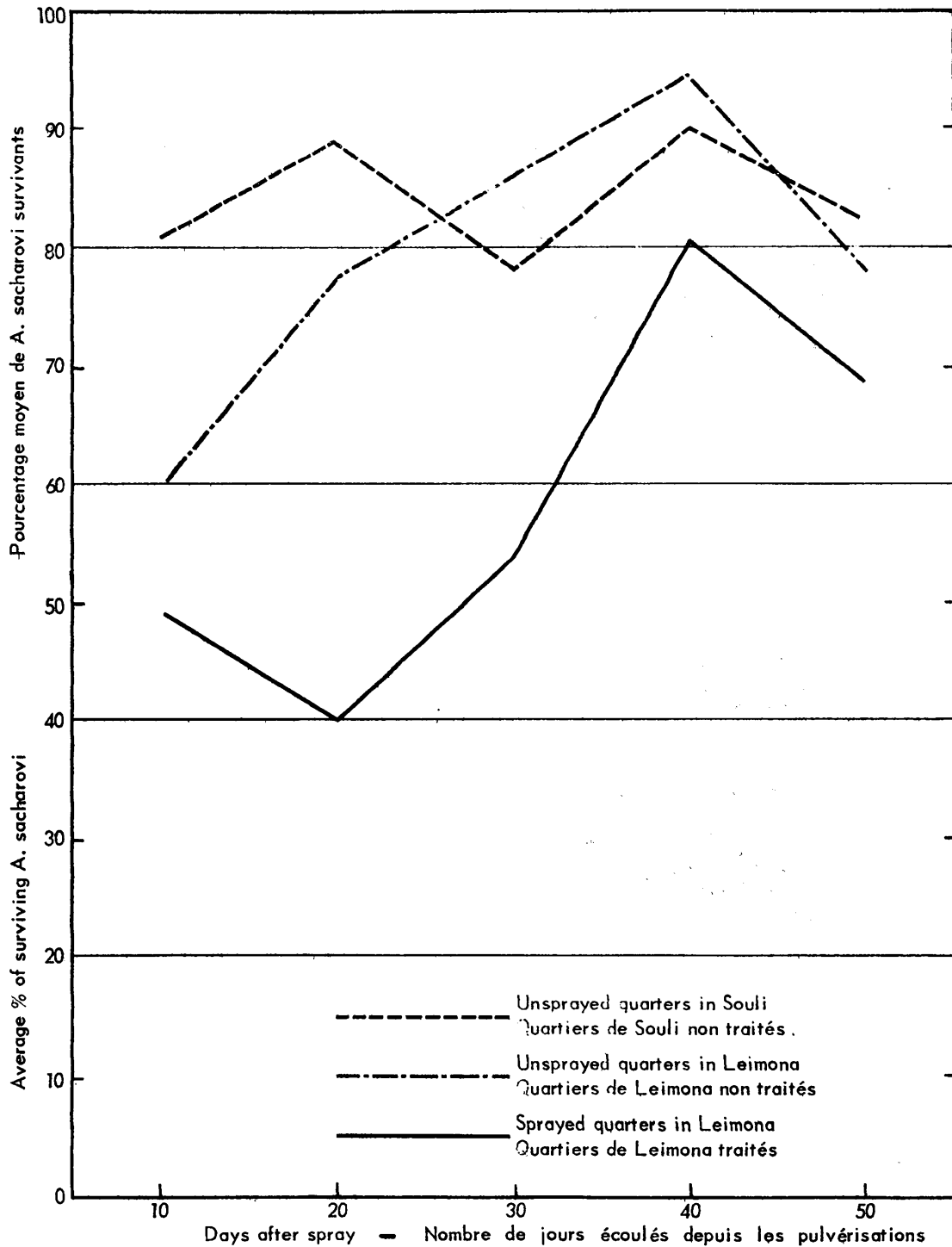


FIG. 3

THIRD 24 HOURS PERIOD  
TROISIEME PERIODE DE 24 HEURES

