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31 October 1947EXPERT COMMITTEE ON MALARIA

The Secretary of the Expert Committee on Malaria has the honour to communicate herewith a digest of a

REPORT ON THE ANOPHELES (MALARIA) ERADICATION SCHEME
KARPAS, CYPRUS, 1946

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(Nicosia, Cyprus Government Printing Office, 1947)

and desires to express his thanks to the Director of the Medical and Health Services, Cyprus, who has kindly authorized him to draft a digest of this report.

(The above mentioned report might be considered as a progress report for it deals only with the first year (1946) of the programme of eradication of malaria vectors from the whole island. During this first year, the eradication campaign began by covering a limited portion of Cyprus, the Karpas peninsula; during the second year (1947) it has covered approximately one half of the island, and it seems that in 1948 eradication will be achieved all over Cyprus. (Editor's Note)

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The island of Cyprus is about 140 miles long (225 km) and about 60 miles wide (96 km) at its widest (see map); its surface is 3,584 sq.miles (9,200 km²). It consists almost entirely of two mountain ranges running from West to East and enclosing a comparatively flat plain, the Messaoria. Numerous other flat areas are found, on the coast, along the streams running to the sea, and in the neighbourhood of Limassol, Larnaca and Paphos. The 35th parallel North crosses the island. Its climate is Mediterranean, the summer months being generally dry and very hot. The highest temperatures are reached in July and August; the maximum degree of humidity is registered in January and the lowest in June and October. The population of the island is 449,490, the rural population being reckoned at 352,957. The density of the population is about 126 per sq. mile (49 per Km²).

Malaria has, for centuries, been a serious problem in Cyprus and the Government had paid great attention to it, particularly since the visit of Sir Ronald Ross (1913). It is not a notifiable disease in Cyprus and therefore its incidence cannot be accurately

stated. During World War II an important military camp in the Famagusta district had to be closed down on account of severe malaria among the troops. With the aid of drainage and plantations, carried out both by the Government and by the people, it had been possible in recent years practically to eliminate elutus-borne malaria, i.e. the malaria associated with the marsh-breeding vector species in the island. But on account of the impossibility of doing any permanent work for the elimination of the breeding places of A. superpictus, such as small and shallow sunlit collections of water in river beds, hillside streams, seepages, etc., only partial and temporary success had been obtained by the use of larvicides and by carrying out partial drainage.

The International Health Division of the Rockefeller Foundation co-operated for several years in the malaria survey of the country. Their survey (1935-1939) showed that Cyprus was one of the most malarious places in the world and that "in every district of the island the malaria rate was as high as was found on the West Coast of Africa, Ceylon or India."

The A. superpictus according to BARBER, had a sporozoite index of 7.5%. Barber (A Malariologist in many Lands, 1946) writes that:

"The amount of malaria in Cyprus is comparable to that in Greece. The larger towns and cities are now nearly free from it thanks to the activities of the British Health authorities, but villages are still heavily infected. In our survey of village children we commonly found blood parasite indexes of seventy per cent; our survey of 1935 consisting of over a thousand examinations, gave average indexes of thirty six parasite infestation and over forty per cent spleen enlargement. Malarial sickness was not uncommon, sometimes rising to epidemic proportions; and like the people of Greece, the Cyprians had acquired no very effective amount of tolerance of the malaria parasites. Cyprus is an example of a condition we find in many places of the world - intense aridity, associated with a high degree of malaria."

When the success of A. gambiae eradication in North Eastern Brazil and in the Nile valley became known, it appeared that anopheline eradication could be attempted in Cyprus. The author of the report visited Egypt in March 1945. Cyprus being an island, had the advantage of an easier defence against re-infestation but, on the other hand, the valley of the Nile had the advantage of being a narrow flat country with easy means of communication and plenty of dust available everywhere for the mixing of Paris green; moreover, A. gambiae was a stranger and the serious epidemic that it had caused morally facilitated the organization of the campaign. It was, however, obvious that given the necessary funds and materials, it would be possible

to eradicate from Cyprus Anopheles superpictus and A. elutus and perhaps all anopheline species at the same time.

It seemed wise to try out eradication on a portion of the island first, rather than start on an all-island scale. Now, Cyprus has at its north-eastern tip a long peninsula - Karpas - which seemed to lend itself very well to this initial programme, not only because it is mostly surrounded by sea and therefore is protected on three sides against re-importation of anophelines, but also because its malaria characteristics are the same as those found in the rest of the island.

The Karpas peninsula is a narrow strip of land some 45 miles long (72 km.) and about 10 miles wide (16 km.) situated at the north-eastern tip of the island. The area of the eradication programme consisted of about 450-500 sq.miles (about 1,150-1,300 km²). The eradication area had to be protected against infiltration of mosquitoes from the rest of the island and a large area called "protection area" was defined, stretching from coast to coast (see map). The eradication and protection areas together covered approximately 700-800 sq.miles (1,800-2,000 km²); they contained 65 villages with an estimated population of 34,000. The two areas include a range of hills with mountains rising to 2,400 feet (800m.) at the Olymbos Mountain; the hills are deeply cut by numerous water-courses. Communications are good in the Southern part of the plains but very poor on the northern side and on the slopes of the hills.

The anophelines recorded in Karpas are the following: A. superpictus, A. elutus, (sacharovi), A. claviger (all these three are known to be vectors), A. algeriensis, A. marteri and A. hyrcanus.

Programme

It was decided to treat the eradication and protection areas by the same method. The whole of these areas was divided into 4 sections, every section into zones, every zone into blocks and every block into plots of an appropriate size. The block is the unit and its proper treatment is the responsibility of a single larvicider.

There were altogether 10 zones and 51 blocks, each block ranging approximately from 10 to 30 sq.miles (25 to 75 km²).

In the 1946 campaign, the whole strategy was concentrated against larvae. A 4-5% solution of DDT in gas oil (fuel oil) was found to be more convenient than Paris green on account of its residual effect against ovipositing females or newly emerged imagoes.

As a drawback of DDT, it has been noticed that gambusiae, crabs, eels and frogs were considerably affected, so much so

that it had been considered that in future the use of DDT as larvicide would be restricted and probably replaced by Paris green.

No residual DDT spraying was applied to the buildings. Even when the imago surveyors needed an insecticide for spray killing of the mosquitoes during their search in houses and stables, ordinary insecticides other than DDT were employed. Provision was made, however, for a DDT residual spraying campaign against hibernating anopheles to be carried out, during the winter of 1946-1947.

Following the preliminary surveys, held with a view to locating all potential breeding places and to training the staff, the organization was complete by April 1946 and the actual field work started on the 15th. During the first months of its existence, many difficulties were encountered and little progress could be made.

Organization

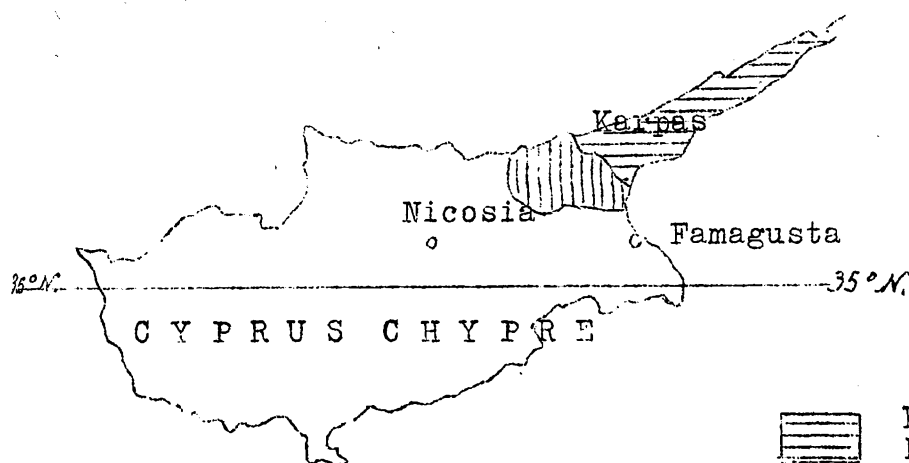
It may be said that the planning of the organization was guided by the principles applied in Brazil and in Egypt for the eradication of A. gambiae, adapted of course to local conditions.

The Director of Medical and Health Services assigned full authority for the execution of the work to the Executive Officer, who was responsible for the planning of the work, the training of the staff and, in short, for the whole conduct of the campaign. He is stationed at Headquarters at Nicosia. He is assisted by two inspectors who are chiefly responsible for surprise checking of the work in all the areas. There is moreover a malaria technician, a store-keeper and the necessary clerks.

The District Officer, who is stationed at Famagusta, is responsible for the field work and the distribution of supplies, and he also carries out surprise inspections. He is assisted by two field inspectors whose task is to check the work of the field staff. All reports are submitted to headquarters through him.

Each section into which the areas are divided has a Section Officer who is responsible for the distribution of larvicides and the equipment to his subordinates. He orders the itinerary to be followed by the imago and larva surveyors under his orders; he checks the work of the Zone Officers, of the DDT-ers, larva and imago surveyors and reports to the District Officer.

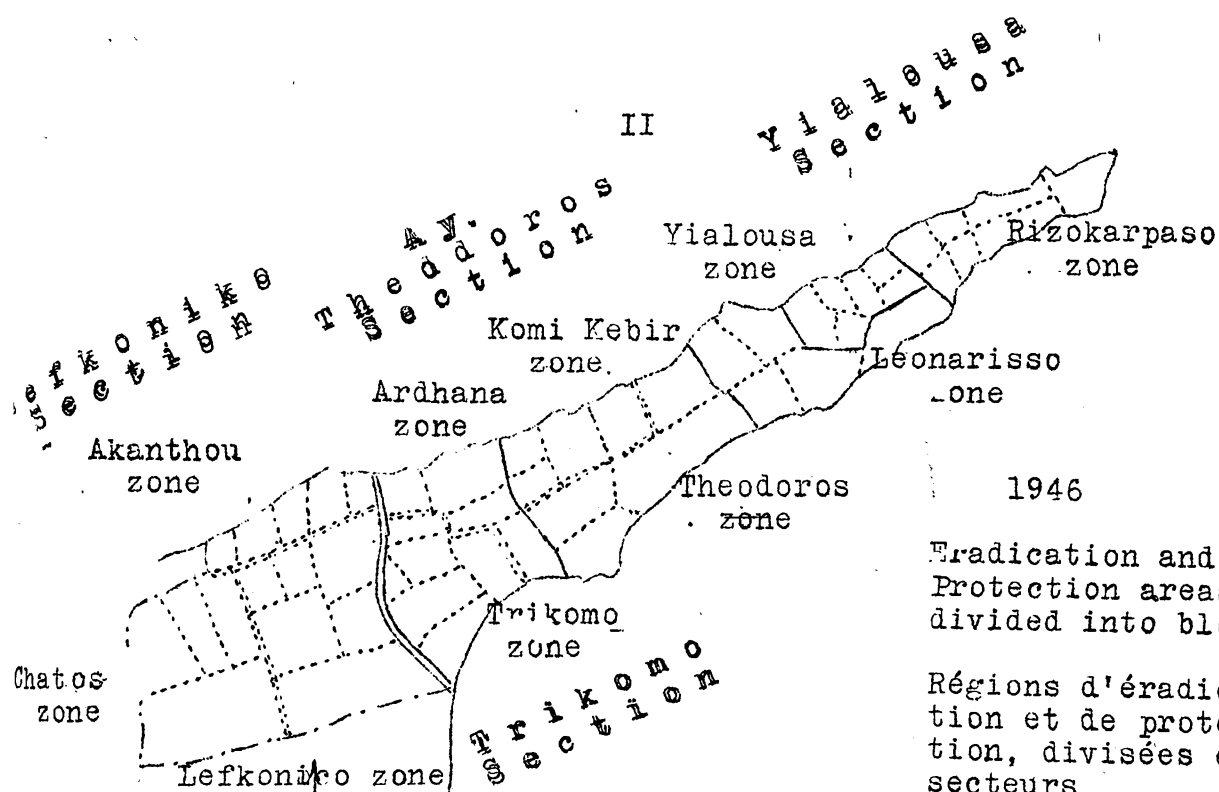
The Zone Officers (8) are the senior officers next to the Section Officers; they issue the material to the workers in their charge and inspect the blocks of their zone, constantly supervising the work.



1946

Eradication area
Région d'éradication

Protection area
Région de protection



1946

Eradication and
Protection areas,
divided into blocks

Régions d'éradica-
tion et de protec-
tion, divisées en
secteurs

There are from 75 to 80 workers, including foremen, larva-and-imago-surveyors and DDT-ers. The larva surveyor must look for any breeding places that may have been left untreated by the DDT-ers and must treat them himself. He must also inspect all the breeding places, collect specimens for identification and report to the Section Officer. The imago surveyor who is always helped by an assistant, carries out searches in buildings and, compulsorily, in suitable catching stations previously selected and numbered; furthermore, he must look for larvae in the house wells. Any anophelines found there are collected and sent to the laboratory for identification. They are captured by spraying ordinary insecticides in buildings after a sheet of cloth has been laid down in order to collect the mosquitoes knocked down.

An independent check-up of blocks reported as negative was also carried out, thanks to the collaboration of the Army and the Boy Scouts. The local military authorities had arranged that several men should be periodically available to carry out this checking and report directly to headquarters on their findings. The Scout Commissioner and the Organizing Commissioner of the Boy Scouts had kindly arranged that a certain number of boy scouts from Famagusta and of High School students at Nicosia, together with a number of others, should be formed into groups under a leader and should comb areas being persistently reported as negative. During their search they were assisted by a headquarters field inspector and by skilled checkers belonging to the staff, but not engaged in the Eradication Service.

The DDT-ers apply the DDT solution to any potential mosquito breeding place; each DDT-er is responsible for one block. These being divided into 12 plots, each plot represents one day's work and is treated on a specific day. This means that every breeding place will be treated every two weeks in accordance with a pre-arranged itinerary. Each DDT-er is allowed about 2-3 kg. . of DDT solution for each working day according to the size of the plot. He carries a spray of the Flit type, two one-litre tins of DDT larvicide and a flag which is hoisted on a post in a place visible from some distance. The flag has a pocket in which the DDT-er inserts a note stating where he is working. Moreover, he is instructed to indicate with chalk in suitable spots, the direction he is following during his movements so that he can easily be traced by inspecting officers.

Badges are worn by the larva and imago surveyors. The latter also carry a flag to indicate the place in which they are working. Every breeding place and every building checked has to be marked with the date, initials and rank of the inspecting person. Any surveyor or officer finding no larvae or no adults in the course of his inspection of a particular block must submit a "negative report", great importance being obviously attached to these negative findings which have to be checked afterwards with particular care.

Development of the campaign and problems met with

A major problem which had to be solved was the finding of absolutely reliable personnel. The men who formerly were working on malaria control had to be painstakingly taught that eradication required an outlook quite different from that of the usual larval control. The experienced men sometimes left the service for jobs involving better wages and a less hazardous occupation, and special advantages had to be offered in order to induce them to remain in the service. As a matter of fact, the work of the DDT-ers and of the inspecting personnel was hard, chiefly on account of the topographical characteristics of the areas, the restricted means of communication and the difficulties in reaching remote breeding places. With the advent of summer, the number of the breeding places and their surface were of course reduced, so that the DDT-ers were prone to assume that some small collections of water had dried up and thus sometimes neglected their work. Moreover in the day-time some stream-beds may appear dry while at night, since the water table rises after sunset, there would be water in them. In such a case, in the day-time stones in the stream beds must be lifted in order to detect possible seepage and probably superpictus larvae. Fresh breeding places during the summer may also be caused artificially and it is difficult to make sure that all of them can be spotted and treated.

While the summer months are generally dry, heavy rains occurred in May and quite exceptionally in June and July 1946, creating many new breeding places. When a set-back in the work was caused by such rains or by other unforeseen circumstances, a "blitz" treatment was resorted to, whereby a weekly instead of a fortnightly treatment of the breeding places was adopted. In the actual larviciding work this entailed the co-operation also of the Zone Officers and even of the Section Officers as well as the surveyors and inspectors. As a consequence of this "blitz" treatment it was found that, unless DDT-ers were absolutely reliable, a weekly application was necessary, particularly in the plain.

As the work was progressing, it was found necessary, about the middle of July, to establish a disinsectization station on two of the main roads leading to Karpas, where all vehicles proceeding to Karpas from the rest of the island could be stopped and sprayed with DDT. However, as no legislative measure was enforced at the time, an increasing number of cars passed without stopping at the stations, which were finally closed about the middle of October. Since then regulations have been enacted rendering compulsory the disinsectization of all vehicles, boats and planes.

Reaction of the population

It appears that the people followed the eradication campaign with interest and expressed satisfaction because they noticed a decrease in malaria as compared with former years. This satisfaction was somewhat lessened when the campaign did not bring about a decrease in the number of biting insects other than mosquitoes. Moreover, a considerable part of the work could not be fully appreciated by the population owing to the fact that it was carried out in places remote from inhabited centres. There was, however, no difficulty for the imago surveyors in entering houses for checking purposes and scarcely any obstacles were placed in their work except for some grumblings when domestic wells were sprayed. And the popularity of the campaign increased when, later, indoor use of insecticides was resorted to.

Financing and costs

Under the Colonial Development and Welfare Act, a sum of £20,000 was allotted and of this, £15,000 was approved for eradication work up to the end of October 1946. The total cost of the eradication programme, from April 1st to October 31st, 1946 including salaries, wages, travelling, purchase of stores, transport, etc., amounted to approximately £12,000 as against the £15,000 allocated.

The following material was used up to 1st October:

DDT larvicide (4-5%): 8,416 gallons (38,600 litres)

DDT insecticide (3%): 160 gallons (740 litres)

Ordinary insecticides: 168 gallons (772 litres)

Moreover, 193 larvicide sprayers and 84 small "flit guns" were used.

(The total cost of the 1946 campaign for the nine months April-December, amounted to £18,000, i.e. on the basis of the 34,000 inhabitants of the two areas, an approximate per capita cost of about 10 shillings or a cost of £36 per square mile.) (from AZIZ, M. Jl. Roy. San. Inst. 67: 5, p.498-509, Sept. 1947). (Editor's Note)

Results

Eradication operations were carried out from 1 April to 16 November 1946 and the following data are summarized hereunder:

A. Assessed in terms of imago or larvae searches:

<u>Zone</u>	<u>Negative for adults</u>			<u>Negative for larvae</u>		
	From	To	No. of weeks	From	To	No. of weeks
Rikokarpaso	18.8	16.11	13	15.9	16.11	9
Yialousa	18.8	16.11	13	15.9	16.11	9
Leonarisso	15.9	16.11	9	25.8	16.11	12
Ayios Theodhoros	14.7	16.11	18	28.7	16.11	16
Komi-Kebir	30.6	16.11	20	30.6	16.11	20
Trikomo	6.10	16.11	6	6.10	16.11	6
Ardhana	8.9	16.11	10	8.9	16.11	10
Lefkoniko*	13.10	16.11	5	13.10	16.11	5
Akanthou*	20.10	16.11	4	13.10	16.11	5
Chatos*	6.10	16.11	6	27.10	16.11	3

*Protection zone.

(In December 1946 and January 1947, not a single anopheles was found in all the 51 blocks.) (AZIZ, M. Op. cit.) (Editor's Note)

The following table shows the weekly total number of premises searched and the number of premises found positive, as well as the number of units of water surface checked each week for anopheles larvae or pupae and the number of units found positive (By unit is meant any water surface of 5 sq. yards, or less.)

Week ended	No. of nouses searched for adults	No. of houses positive	No. of units searched for larvae	No. of units positive
20.4	507	88	2,793	18
27.4	586	75	3,176	41
4.5.	485	83	3,723	39
11.5	579	110	4,170	27
18.5	604	79	4,248	53
25.5	674	74	6,217	42
1.6.	606	76	6,400	83
8.6.	690	55	7,116	69
15.6	564	47	5,411	16
22.6	604	40	3,445	9
29.6	762	42	9,075	14
6.7	750	8	8,096	24
13.7	724	7	9,308	25
20.7	730	11	9,382	22
27.7	882	1	10,213	7
3.8	870	15	9,228	nil
10.8	803	13	10,096	5
17.8	1,179	7	10,281	nil

Week ended	No. of houses searched for adults	No. of houses positive	No. of units searched for larvae	No. of units positive
24.8	1,032	3	11,203	5
31.8	1,051	2	9,920	10
7.9	1,494	7	15,336	13
14.9	1,545	7	13,616	1
21.9	1,544	nil	12,957	nil
28.9	1,582	nil	13,868	nil
5.10	1,431	nil	9,366	nil
12.10	1,734	3	8,625	4
19.10	1,634	1	6,944	nil
26.10	1,565	nil	7,934	3
2.11	1,187	nil	5,979	nil
9.11	1,028	nil	8,091	nil

B. Assessed in terms of malaria indices

Malaria records for all the villages of the eradication and the protection areas are unfortunately lacking, except for the following which in 8 out of 9 villages, show a remarkable drop of the parasite index and also of the spleen index following the eradication campaign:

Eradication
started on 1 April

Villages	Fall survey 1944		Fall survey 1945		Fall survey 1946	
	Spleen index	Parasite index	Spleen index	Parasite index	Spleen index	Parasite index
Akanthou	30.0	50.0	9.3	12.9	8.0	8.0
Kornokipos	11.0	25.7	8.3	27.8	0.0	2.0
Ayios Andronikos	18.5	40.7	8.0	10.0	6.0	6.0
Neta	15.4	38.5	7.1	21.4	6.9	10.4
Platanisso	25.0	32.0	23.5	15.7	12.1	6.3
Artemi	35.3	58.8	50.0	50.0	42.1	36.9
Platani	25.0	52.0	29.4	21.5	16.0	16.0
Ayios Nikolaos	12.0	28.0	0.0	6.0	0.0	4.0
Malounda	22.2	23.3	18.2	9.1	27.8	27.8
Averages	29.9	39.8	14.4	16.4	9.9	9.9

13 infants (1 at Kornikopos, 4 at Neta and 8 at Platanisso) were examined and none of them was found to have spleen or blood parasites.

x

x

x

(After such encouraging results, plans were made to extend eradication over one half of the island in 1947. Prior to the larviciding campaign, residual treatment with DDT was applied, in the winter of 1946-1947, to all outbuildings such as stables, sheepfolds, pigsties and even to some sleeping rooms: A solution of DDT in gas oil similar to that used for the antilarval campaign was employed. Also possible natural shelters of anophelines in the forest area were treated in co-operation with the staff of the Forest Department. Map 3 shows the areas into which the island was divided for the 1947 campaign. The Southwestern portion of the island has been submitted to intensive control; after a systematic winter campaign against hibernators a careful antilarval campaign was carried out, which made it possible to train the staff which will be required in 1948 for the eradication campaign in this remaining portion of the island (from AZIZ, M. Op. cit. Editor's note.)

CYPRUS = CHYPRE

Cy. Andreas

