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

A SHORT REPORT ON THE ERADICATION OF ANOPHELES
SERGENTI FROM THE OASES IN EGYPT - 1946 - 1948

by Dr. S. MADWAR and Dr. El SHAWARBY, of the Ministry of Public Health, Cairo.

1. Introduction

The eradication of the exotic species A. gambiae from Egypt (1945) and Brazil (1940) encouraged the Egyptian Government in co-operation with the Rockefeller Foundation to attempt the eradication of other indigenous species of anopheles. The Dakhla and Kharga oases being highly malarious and fairly well isolated furnished suitable conditions for the experiment.

1.1 General description (see Map, page 3)

The Kharga oasis is 200 kms to the South West of the Nile Valley (lat. 24° 30' - 25° N., long, 30° 30' E. Green) opposite the cities of Luxor and Kom Ombo. Dakhla is 200 kms to the west of Kharga (lat. 25° 30' N. long 28° 30' - 29° 30' E. Green). The populations and superficial areas are given below

| Oasis | Population | Total area | Cultivated land | Rice area |
|--------|------------|--------------|-----------------|-----------|
| Kharga | 11,000 | 2,800 sq.kms | 5,000 acres | 800 acres |
| Dakhla | 21,000 | 2,600 sq.kms | 10,000 " | 3,700 " |
| Total | 32,000 | 5,400 sq.kms | 15,000 " | 4,500 " |

(1,000 acres = 4.046 sq.kms; 1 sq.km = 247 acres)

* For reasons of economy, no translation made in French

The water supply is drawn from artesian wells. There are about 1,200 of these each with an average depth of 800 - 1600 feet. The cultivation is sparsely distributed according to the position of the wells at a length of about 120 kms in Kharga and 80 kms in Dakhla. The main crops are dates, rice, wheat and citrus fruits. The roads are very hard and bumpy with sanddunes intervening. There are about 9,300 houses.

2. Malaria Survey

Before starting the campaign a preliminary malaria survey carried out in October 1945 gave the following results:-

2.1 Parasite and Spleen indices

| Oasis | Examined | Parasites | | | | Spleen | |
|--------|----------|-----------|------------|-------|-------|---------|------|
| | | Positive | % Positive | Vivax | Falc. | Spleen+ | % |
| Kharga | 501 | 32 | 6.3 | 24 | 8 | 104 | 20.5 |
| Dakhla | 961 | 141 | 20.6 | 70 | 71 | 427 | 61.7 |
| Total | 1462 | 173 | 11.7 | 94 | 79 | 531 | 36.3 |

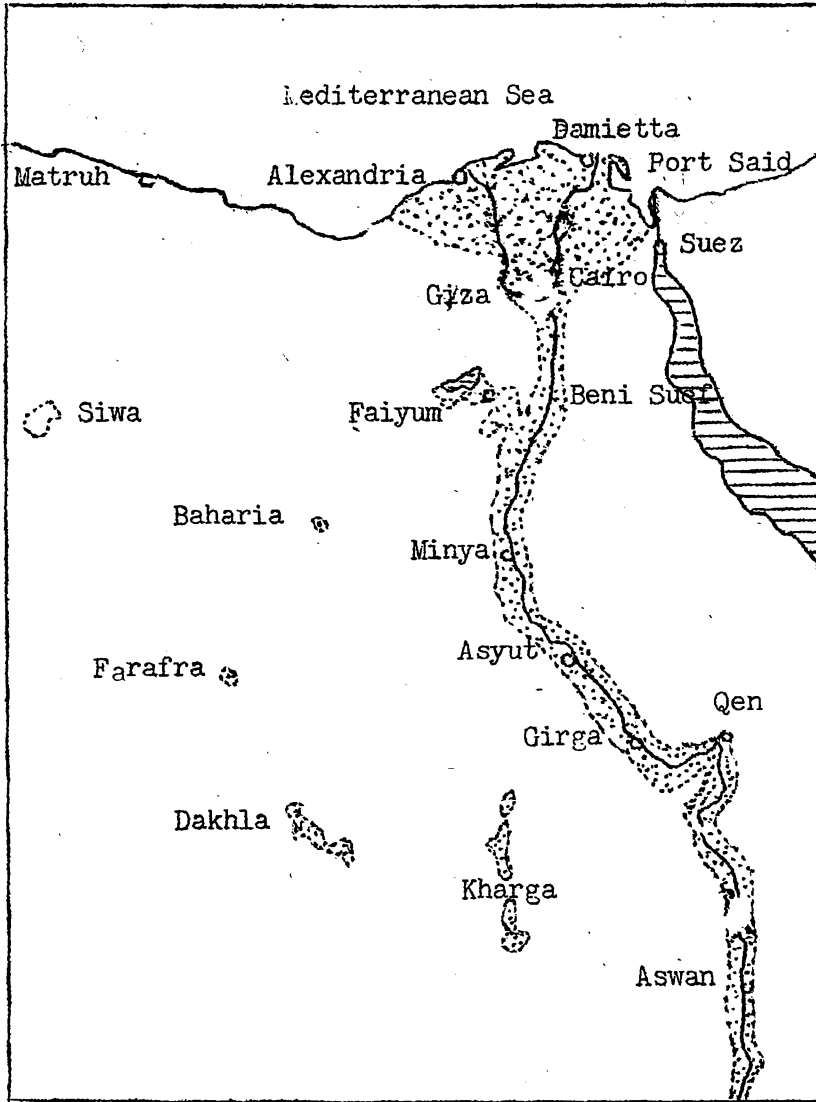
The spleen rate loses much of its value in the oases as schistosomiasis is rather common especially at Dakhla.

2.2 Entomological findings:

Anopheles larvae. The unit of larval search is 5 sq., or linear metres. A well is considered as one unit.

| Oasis | Units searched | Posi- tive | % | <u>A.ser-</u> <u>genti</u> | <u>A.pha-</u> <u>roensis</u> | <u>A.multi-</u> <u>color</u> | <u>A.d'thali</u> |
|--------|----------------|---------------|------|-------------------------------|---------------------------------|---------------------------------|------------------|
| Kharga | 4,368 | 696 | 11.4 | 66.7 | 27.5 | 5.4 | 0.4 |
| Dakhla | 2,916 | 484 | 16.6 | 69.5 | 26.5 | 1.0 | 2.7 |

SKETCH MAP showing location of the Oases of
KHARGA and DAKHLA



Anopheline adults. The unit of imago search is the house.

| Oasis | Houses searched | Posi- tive | % | <u>A.</u> | | | |
|--------|-----------------|---------------|------|--------------|--------------|----------------|----------------|
| | | | | <u>serg.</u> | <u>phar.</u> | <u>multic.</u> | <u>d'thali</u> |
| Kharga | 417 | 254 | 60.9 | 87.7 | 12.5 | 0.3 | ? |
| Dakhla | 968 | 959 | 99.0 | 80.0 | 13.5 | 5.5 | ? |

Four indigenous anophelines are found in the oases: A. sergenti, A. pharoensis, A. multicolor and A. d'thali, of which A. sergenti is the most abundant and A. d'thali the least numerous. It is known that A. sergenti is a more efficient malaria vector than A. pharoensis. The others have not been proved to transmit malaria in nature.

3. Organization of the Eradication Campaign

The campaign was started in January 1946 and was aimed at the eradication of the four anopheline species. This work was divided into three phases:-

1. Control work.
2. Survey work.
3. Test for eradication.

3.1 Control Work

This was done by treating all potential breeding places as actual breeding places on a weekly cycle for a reasonable length of time until no larvae or adults were found.

This is attained by dividing the whole area of work into zones; a zone being that unit of superficial area in which all breeding places can be covered once weekly by one man - the "molahiz" or overseer. If the molahiz carries out his work efficiently; in an area of a suitable size, using a potent larvicide it is clear that all larvae will be destroyed. It follows therefore that there being no production of new generations, the remaining adults will, in time, die. Eradication will then have been achieved, provided, of course, that no new infestations occur.

The zone, the molahiz and the larvicide are therefore the keystones of eradication and the remainder of the organization is intended to keep them working

at full capacity and co-ordination... Each four to six zones form a district - "magnouah" - supervised by a foreman or "morakib" whose function is to control the size of the zone and the number of overseers according to changes in the size and number of potential breeding places.

In addition, he trains the overseer, sets his itinerary and checks his work by both visiting him at least once weekly and also by searching for larvae in the previously treated places. He also supplies the overseers with larvicide and equipment and checks the daily and weekly forms. A number of districts form a post, with its chief and assistants, transport and stores and a group of posts form a division.

The Kharga division consisted of three posts; Kharga and Dakhla A and B. It was made up of a total of 17 districts and 71 zones.

| | Districts | Zones |
|---------------------------------------|-----------|-----------|
| Kharga post (Doctor and 3 Assist.) | 8 | 29 |
| Dakhla A. (Engin. and 2 Assist.) | 4 | 20 |
| Dakhla B. (Engin. and 3 Assist.) | 5 | 22 |
| | <u>17</u> | <u>71</u> |

The number of overseers depended upon the size of the breeding places in the zone and varied with the season. Thus in January and February when evaporation and cultivation were at a minimum, and seepage and surface water at a maximum, the number of overseers was greater than that of the zones. From June to December when rice cultivation takes place the number of overseers was greatest. The boundaries of zones were frozen from the beginning of the campaign to keep statistical data correct. In case their number needed to be changed subdivision was resorted to. The lowest number of overseers was 71 and the highest 285 during rice cultivation.

3.2 Survey work

The larvicidal work of the molahiz (overseer) is the keystone of eradication and the checking of this work is all important for attaining that goal. The molahiz is first checked by his own form in which he records the details of his

daily work. He is again checked by the foreman who is in constant touch with him. A third checking is done by the larvae and imago scouts. This search for larvae and adults is carried out by an independent staff under the direct supervision of the chief of the post. The unit of the larval search is 5 linear or square metres and the unit for the adult survey is the house or the barn.

In searching for larvae and adults, the number of scouts attached to each post was not great at the start of the campaign as there was no difficulty in finding larvae or adults. As the larvicidal work became more and more effective the scouts increased in number so that they could cover the whole area under control in searching for the few missed foci of breeding or hiding.

3.3 Malaria Rates, 1945-1949

Parasite Rates

| Year | Post | Films exam. | Positive | % | Vivax | % | Falc. | % |
|-----------------|------------------|--------------|----------|--------------|---|------|-------|-----|
| 1945 | Kharga | 501 | 32 | 6.3 | | | | |
| | Dakhla | 961 | 141 | 20.6 | | | | |
| 1946 | Kharga | 2532 | 208 | 6.2 | 202 | 8.0 | 6 | 0.2 |
| | Dakhla | 6847 | 246 | 13.8 | 697 | 10.1 | 249 | 3.7 |
| 1947 | Kharga | 1720 | 62 | 3.6 | 62 | 3.6 | 00 | 0.0 |
| | Dakhla | 3639 | 39 | 1.1 | 25 | 0.7 | 14 | 0.4 |
| 1948 | Kharga | 1372 | 32 | 2.3 | 32 | 2.3 | 00 | 0.0 |
| | Dakhla | 1968 | 6 | 0.3 | 6 | 0.3 | 00 | 0.0 |
| 1949 (Sept.) | Kharga Dakhla | 1191 1935 | | 1.34 0.56 | All new born infants of 1949 (1182 in all) were examined: only one was found infected | | | |

3.4 Entomological findings

I Larval Survey

| Year | Oasis | No. of units searched | No. of units positive | A.serg. | A.phar. | A.multic. |
|------|------------------|-----------------------|-----------------------|---------|---------|-----------|
| 1945 | Kharga Dakhla | 4368 | 696 | 464 | 191 | 41 |
| | | 2916 | 484 | 336 | 128 | 20 |
| 1946 | Kharga Dakhla | 343071 | 1141 | 994 | 51 | 96 |
| | | 368045 | 1632 | 1095 | 173 | 361 |
| 1947 | Kharga Dakhla | 667647 | 26 | - | 12 | 14 |
| | | 2063700 | 961 | - | 948 | 13 |
| 1948 | Kharga Dakhla | 773578 | 16 | - | - | 1 |
| | | 978109 | 3118 | - | 7468 | 316 |
| 1949 | Kharga Dakhla | 208854 | 3333 | - | 3237 | 90 |
| | | 68977 | 2803 | - | 2302 | 494 |

II Imago Survey

| Year | Oasis | No. of houses searched | No. of houses positive | A.serg. | A.phar. | A.multic. |
|------|------------------|------------------------|------------------------|---------|---------|-----------|
| 1945 | Kharga Dakhla | 417 | 254 | 223 | 30 | 1 |
| | | 968 | 959 | 767 | 139 | 53 |
| 1946 | Kharga Dakhla | 44236 | 1073 | 922 | 27 | 104 |
| | | 63317 | 3223 | 2526 | 50 | 647 |
| 1947 | Kharga Dakhla | 67417 | 49 | 4 | 19 | 26 |
| | | 134868 | 250 | - | 214 | 26 |
| 1948 | Kharga Dakhla | 66682 | 15 | - | 14 | 1 |
| | | 76539 | 4301 | - | 3012 | 1239 |
| 1949 | Kharga Dakhla | 34856 | 1397 | - | 1348 | 68 |
| | | 8782 | 1026 | - | 684 | 550 |

It will be noted that:-

i. The larval and imago survey carried out in 1945 lasted 10 days in October whereas the other surveys were carried out during the whole year.

ii. All control work was stopped at Dakhla oasis from May 1948 onwards to test for eradication. (See 3.5)

All control work was stopped in Kharga oasis from February 1948 onwards.

iii. Note that A. sergenti were not found from January 1947 till now in spite of stopping all control work. The other two species made their appearance gradually after stopping control work.

3.5 Test for Eradication

The test of eradication is applied in areas which have remained free from both larvae and adults for a reasonable period. This is done by stopping all control work and at the same time intensifying surveying especially during the most favourable season for breeding of the eradicated species.

As the whole division was reported free from A. sergenti from January 1947, two districts from the Dakhla "A" post were put under test during September and October and 156966 units were surveyed for larvae and 7855 houses for adults all with negative results.

In May 1948 both of the Dakhla posts were put under test by discontinuing all larvicidal work and searching for A. sergenti. 259335 units were searched for larvae from May till December and 20182 houses were searched for adults. Not a single A. sergenti was found. The other species, A. pharoensis and A. multicolor, were found both in the imago and larval stages.

4. Work done

4.1 Larvicide

A 5 percent solution of DDT in solar oil was used for treating the breeding places by means of the ordinary hand flitgun at a rate of 0.2 cc. per square metre. About 494 tons of this solution were consumed during the three years of the campaign. Adulticidal work was reserved for the treatment of transport arriving in the oases from the Nile valley to prevent reinfestation. This adulticide was a 0.1 percent pyrethrin in kerosene.

4.2 Personnel

The number of the permanent staff taking part in the campaign was 27 including doctors, engineers, assistants, clerks and mechanics. The rest of the personnel

were all daily paid and included overseers, scouts and labourers. Their monthly average was 219 in 1946, 221 in 1947 and 101 in 1948. The cause of the great drop of the 1948 figure was the stoppage of control work in Dakhla.

4.3 Transport

A total of 21 vehicles operated during the three years. Seven of these became quite unserviceable and two only returned in good condition. The percentages of vehicles off the road were respectively 37.5, 54.5 and 52.6 in the three years of work, which will give an idea of the poor condition of the roads.

4.4 Expenditure (See also 6.4)

The money spent during the first three years of the campaign was about £E 66,000, the bulk of which (£E50,000) was for labour. The number of different persons of the cases who worked in the campaign (no matter what the period of work) was about 1600. These were all males of the age group of 20-35 years. Thus about £E 30 were handed to each of about 38.5 percent of the working class of the oasis which brought about an improvement of the social condition of the population.

5. Discussion

5.1 Difficulties encountered

(a) Most important was the problem of transport.

(b) The shortage of repair shops for tools, soldering and blacksmithery.

(c) The difficulty in looking for missed breeding places. The desert and hills are not well known by the people and the maps do not show all of them and even the well known places were beyond the reach of the available cars.

(d) The people are not used to clearing their channels from algae and even properly watering their fields thus leaving much seepage, and also the continuous flow of the wells in some cases produced much unused water which was left to form wide sheets of surface water.

(e) The difficulty of getting the appropriate number of literate people to train as scouts.

(f) The difficulty of procuring living accommodation for the staff of the campaign added to the very hot summer which discourages a difficult job requiring almost continuous walking in the open desert.

5.2 Failure of eradication of the other species

Eradication work is an "all or nothing" phenomenon so that it can only be achieved by killing a hundred percent of the species concerned. The method used against the anophelines concerned was to kill all the larvae before they could complete their life cycle. This necessitated an attack on all actual and potential breeding places of the different species and the complete destruction of the larvae in them. To arrive at the goal of eradication two important points must therefore be achieved:-

1. A full knowledge and treatment of all the breeding places.
2. Killing of all the larvae.

Now a study of the main breeding places of the 3 species dealt with will explain why we succeeded in the eradication of A. sergenti and failed with the other two.

A. sergenti breeds mainly in slow moving streams, in canals with or without algae and in rice fields, but in special places: either in the small channels in the rice fields or at the edges where the water is moving slowly. It is also more or less domestic so that it enters houses and breeds not far from them. During the search for adults many of them are killed in the houses by flitting. It is therefore apparent that the breeding places are easily found and are accessible to the hand flitgun overseer. A. pharoensis on the other hand breeds mainly in rice fields which can never be covered perfectly by the overseer with the present means of spraying. Furthermore it is more or less wild so that its absence from houses does not mean a negative result. A negative result for the larvae in rice fields cannot be depended upon as it is almost impossible to examine every puddle in a rice field.

A. multicolor breeds mainly in seepage and in brackish puddles of water, many of which are very small and are sometimes only shining with water. When these are numerous, some are easily missed by both the overseer and the scout. Some foci far in the desert could, in addition, have been missed.

5.3 Justification for the expenses

There remains one question to be answered - Do the results achieved amply justify the expenditure of such great funds of money? It is certainly so, for.

1. After all, the money spent was mainly labour wages or in other words given to the dwellers of the oases.

2. The eradication of the main carrier of malaria A. sergenti will most probably keep the malaria incidence at the very low level found at present.

3. Moreover the future development of these oases and the prospective digging of many artesian wells to increase the land cultivation makes it a sound policy to eradicate the dangerous carrier before such land development schemes are started.

6. Summary

1. A. sergenti - the most important carrier - was eradicated. No A. sergenti was found even after all control measures in Dakhla and Kharga oases were stopped for a whole year.

2. Malaria conditions in both oases were greatly improved after the eradication of the main vector. The percentage of malaria dropped from 12.2 percent in 1945 to 0.8 percent among the total population of 32,000.

3. Malaria in new born infants was .08 percent in 1949 after stopping all control work.

4. The total cost of the campaign was £E 70,000 (\$ 200,900) over a period of four years, of which £E 60,000 (\$ 172,200) was spent as wages to local people of the two oases.