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Report on Malaria Eradication in Iran

Submitted to the Executive Board by the Government of Iran

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MALARIA ERADICATION IN IRAN

Introduction

1. During the reign of Shah Abbas the Great, in the sixteenth century, some 100,000 agricultural workers moved from Isfahan to the Caspian area. It is stated that in a short period of time, some 20,000 died of malaria and the rest had to return to Isfahan.
2. Studies made in the same area in 1951 showed that the disease is hyperendemic. The infection rate was generally 50 to 60 per cent and in many localities as high as 65 and 85 per cent. Malaria control began in this area in 1949, and covered the whole malarious areas of the Ostan by 1954 and expanded into an eradication operation in 1957. Spraying was discontinued and the greater part of the Ostan was put under consolidation by 1959.
3. During 1962, more than 500,000 persons spent their summer vacations in Guilan on the shores of the Caspian Sea and enjoyed the beautiful scenery along with the more than 850,000 inhabitants of the area. During that year the personnel of Malaria Eradication Service, health dispensaries and volunteer collaborators collected 137,706 slides and only 111 positives were found. Most of these were either from 65 villages of the 3,015 villages of the Ostan which had become infected after the movement of positive cases from other regions of Iran into the protected areas, or from travellers and visitors. Most of the positives (106) were radically cured by agents of the Malaria Eradication Organization; the rest travelled out of the Ostan. A total of 208 villages were sprayed. None of the malaria infected cases died.
4. In the period from 1933 to 1960, the surface of land under cultivation in Guilan increased 2.05 times and the crop production 1.88 times. Although the population increased 2.45 times in this period, the per capita income almost doubled.
5. With the great success of the malaria eradication programme in Iran, the old proverb, "If you want to die, go to Guilan" may now be replaced by, "If you

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look for work and pleasure go to Guilan".

History of malaria in Iran

6. Malaria has been endemic in Iran since ancient times and has had a serious effect not only on the health of the people but also on the economy of the country. In 1950 it was estimated that more than 60 per cent of the population (13 million) were living in malarious areas and that four to five million persons were infected each year. Owing to the absence of health facilities and to the lack of proper morbidity and mortality statistics, it was impossible to obtain accurate data on the number of malaria cases and of deaths attributable to this disease. However, available figures show that malaria has been the primary health problem prior to the commencement of wide-scale control activities in 1950. The death rate due to malaria was also very high in the past. Of 233,880 cases diagnosed as malaria in Ministry of Health dispensaries and hospitals in 1934, 9,730 died of the disease.

7. In 1947, 1,900,926 cases were seen at 115 hospitals and 350 dispensaries of the Ministry of Health and 4,393 of the patients died. Of these, 494,598 were diagnosed as malaria and of these, 515 cases resulted in death. In view of the fact that only a small proportion of patients are seen by the Ministry of Health units, it is fair to assume that the true number of malaria cases should be at least ten times higher.

8. Malarimetric studies carried out by a few foreign scientists (since 1921) and by the Iranian malariologists (since 1932) have shown that malaria was found everywhere and was highly prevalent. The lowest rate found was about 35 per cent. In many areas, from 85 to 100 per cent of the children had enlarged spleens, the enlargement in most cases descending to the umbilicus. Dr. John Gilmour in his "Report on an Investigation into the Sanitary Conditions in Persia", written 38 years ago, states that in one village the oldest inhabitant was forty-five. In this village a woman carrying a baby, on being questioned,

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replied that she had had six children but that the one she was carrying, was the sole survivor. The others had died of fever. The survivor was about a year old; its spleen was enlarged to the level of its navel. Dr. Justin M. Andrews in his report, "Planning a Malaria Control Programme for Iran" stated that he believed that this picture was still true in 1950.

9. There is no doubt that the children are the most vulnerable group. Many surveys in different parts of Iran have shown that only half of children born in rural areas reach the age of fifteen. Observations made in several villages after the anti-malaria campaign began are heart-warming. Mothers would look with admiration at their little children playing in the streets and say, "Now we can see our children on their feet walking and playing around and making a noise. Before the control operation they all died and our houses were mournfully quiet."

10. During the 1930's more than half, and sometimes two thirds, of the labourers brought from the provinces to work in various plants and factories of the Caspian Region or on the farms around Teheran were dying of malaria. Most fertile lands were completely deserted or partially used. In many areas farmers were even unable to collect their harvests. The effect of malaria on agriculture may be seen from the following data:

In the years 1926-1933, a total of 100,542 hectares of land was under cultivation in Guilan, producing only 213,011 tons of wheat, barley and rice;

In 1960 the cultivated area was increased to 206,767 hectares with an output of 402,215 tons;

The rate of increase of areas under cultivation throughout Iran during the period 1946-1949 (prior to malaria control activities) was 3.9 per cent (80,000 hectares) for wheat and 4.1 per cent (28,000 hectares) for barley.

After the implementation of the malaria control programme from 1949 to 1953, the area under wheat cultivation increased by 37.3 per cent (758,000 hectares) and that under barley cultivation by 42.7 per cent (300,000 hectares).

11. Finally, it is believed that malaria has been the main cause of migratory movements in several parts of the country, as the inhabitants have moved in order to avoid the deadly grip of the disease. Many cities, including Teheran,

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were deserted during the malaria transmission season and people would move to mountainous villages to escape infection.

Anti-malaria measures before 1950

12. It is recorded that quinine was first administered by Dr. Dixon, special physician to the Crown Prince Abbas Mirza, to the King Fatah-Ali-Shah Ghajar, who succumbed to malaria in Teheran. In the following years this drug began to be used by physicians who had received training in Western medicine. The wide use of quinine was started in Iran in the 1930's by the Ministry of Health, and at one time General Dr. Coulogner, Director General of Health (1933-1935), expressed the view that the best action would be to spend the entire budget of the Health Department on quinine and thus prevent the people from getting malaria. For a number of years, the malaria budget was spent mainly on anti-malaria drugs. In a few areas other methods such as biological, engineering or agricultural measures were taken: filling in and drainage of sewage (Gambusia in Bandar Pahlavi and Babol in 1928); clearing of ditches and canals and riverbeds (Babol in 1931 and Gorgan in 1940); canalization of swamps (Savoj Bolagh in 1940); organized larval control, begun in 1944 by the American Army Malaria Control Unit in Khorramabad, and extended from 1945 to 1947 to Isfahan and Shiraz, Kurdistan, Kermanshah and Bushire and north of Teheran, Khorramshahr, Ahwaz and Palasht area. In most of these operations, army personnel trained at Khorramabad or trained under the latter group, were used as well as local labourers; the initiative was left with the chiefs of local health departments. Similarly, the oil company conducted larval control for many years in Abadan Oil Field Areas. DDT-spraying was introduced for the first time in 1947, when 26 villages in the Palasht area were sprayed with DDT in Kerosene. This programme was continued in 1948 and extended by the Ministry of Health to an additional 39 villages in the districts of Khash, Iranshahr and Bampur.

13. According to the recommendations of Dr. J. Andrews and Engineer L. Hall, who visited Iran in 1948 and 1949, and of the WHO Consultant Team headed by Dr.

Gramiccia and Engineer Pavanello, a special unit for the execution of the control operation was organized as part of the Plan Organization; later, all malaria control activities were centralized in the Public Health Department of the Ministry of Health. Also a tentative control programme, based on one type of activity, was devised to be developed in three consecutive stages (demonstration, operation and maintenance), all on a decentralized basis. The first phase (one year) was to be limited to a demonstration of the application of DDT in hyper-endemic areas. It was also recommended that two annual applications of a 5 per cent solution of DDT in kerosene be replaced by one application of water-wettable DDT, and that the effect of both formulations be evaluated.

14. During the operational phase, efforts were supposed to be made to extend DDT spraying to every village in which malaria was a serious health problem, and the programme was to be increased by 300 per cent each year over the activity of the demonstration phase. It was expected that some recession in organization and activities would be possible during the maintenance phase; at the same time, however, an alert watchfulness would have to be maintained in areas where malaria had occurred.

15. This programme received the full support of the Ministry of Health and the Plan Organization. In 1949 the spraying operations began, as planned, with a demonstration phase. Four cities and 537 villages were sprayed in 13 different areas of the country where malaria was hyper-endemic. Fifty per cent water-wettable DDT was used and 158,629 persons were protected. The selection of the areas was based chiefly on reports of health departments and dispensaries.

16. An evaluation of the effect of water-wettable DDT was made in one village in 1949 by the WHO Consultant Team of the Caspian Region and expanded to 8 villages of the region in 1950. Kerosene-DDT and water-wettable DDT were compared in 1949 in 2 villages of the Varamin area by Dr. R. P. Dow.

17. Training programmes were organized in Teheran for fifteen physicians and 100 field workers, and the first group of Iranian technicians (2 physicians and

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4 engineers) was sent to Italy for training in malaria control.

18. These preparations culminated in the official organization of the Malaria Control Service and the assignment to Iran of a WHO Advisory Team for Malaria Control. Thus the year 1950 may be considered as the first year of the operational phase of malaria control in Iran.

Malaria control operations in Iran

19. For the first two years (1950 and 1951) the teams of the Malaria Control Service were carrying the responsibility for both survey and spraying operations. Soon it was found that the expansion of the programme or its evaluation should be planned and based on sound and sufficient malariological studies. This was not possible however because of the great burden and double responsibilities of the physicians in charge of the malaria control teams. Thus, late in 1951, the Institute of Malariology was organized, with the co-operation of the Ministry of Health, the University of Teheran and WHO, attached to the Chair of Parasitology of the Faculty of Medicine, where studies on malaria epidemiology and entomology were already being carried out on a small scale. The activities of the Institute started in the spring of 1952 with the objective of performing malarimetric surveys throughout the country to assess the effectiveness of field operations, plan the expansion of control operations into new malarious areas, train the necessary survey and operational personnel and carry out research on specific problems as necessary.

20. The responsibilities of field operations was given to engineers who proved to be very capable of administrating the spraying operations. Finally, the Scientific Council of the Institute was given the role of over-all planning of survey and spraying operations and their evaluations.

21. With the expansion of the anti-malaria operation, the malaria control service was raised from the status of a branch of a sanitary engineering division of the newly organized health department to the status of a division. In 1956 the Malaria Control Service was also granted administrative authority and full control of every operational and financial aspect of the programme, which had

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already been decentralized on a regional basis.

22. During the period 1950 to 1956, the programme was expanded over many areas of the country: from a coverage of 7,258 villages and 2,081,000 persons in 1950, the campaign had expanded by 1956 so that it was possible to protect 4,558,700 persons living in 19,429 villages.

23. For the first time also a surveillance scheme was put into operation in 1955 in the Varamin area of Central Ostan, where spraying had been carried out since 1949 and had been discontinued only where malaria incidence had fallen to nil as demonstrated by malarimetric surveys. This programme was extended in 1956 into new areas reaching similar stages in 4,115 villages in Azerbaijan, Kermanshah, Khuzistan and Fars, Mazendaran and Teheran.

24. Based on recommendations of Dr. Paul F. Russell and Dr. M. A. Farid, the malaria experts of WHO, after their visit to Iran in 1955 for a review of the programme, preparations were made for the transformation of the control programme into an eradication campaign, to begin in 1957 with full support of the Government.

25. In view of the excellent results obtained during the previous years of malaria control, and in accordance with the policies of the World Health Organization, the Government not only agreed with this programme but also gave it its full support, allocating the greatest sum that had ever been given up to that time to any health programme. The Government also requested the continuation of assistance from UNICEF, WHO and the United States Agency for International Development in its endeavours.

26. Spraying, survey and training 1950-1956: A summary of spraying, survey and training activities during the period 1950 to 1956 inclusive is given in tables 1, 2 and 3 below.

Table 1 Spraying Operations 1950-1956

Year	Villages Sprayed	Population Protected	Premises Sprayed	Insecticides Consumed		
				DDT 75%	DDT 100%	DLD
1950	7,258	2,088,399	1,324,911	349,925	43,480	-
1951	5,194	1,572,405	559,156	345,912	36,892	-
1952	11,107	3,286,740	954,962	961,757	42,375	-
1953	14,542	4,243,938	731,355	1,392,771	42,100	-
1954	15,405	3,915,000	722,000	1,337,300	14,587	-
1955	16,106	3,885,800	725,000	826,800	7,075	39,363
1956	19,427	6,564,100	740,222	881,246	932	5,557

Table 2 Malariometric Surveys 1950-1956

Year	Malariometric Surveys		Laboratory Activities					Total Positives
	Villages Surveyed	Population Examined	Slides Examined	Vivax	Falc.	Malaria	Mixed	
1950	120 ^{a/}	8,006	-	-	-	-	-	-
1951	108 ^{a/}	5,719	-	-	-	-	-	-
1952	162	13,752	12,932	84	39	22	2	147
1953	617	45,783	45,035	271	141	78	-	490
1954	1,893	93,379	91,873 ^{b/}	387	521	96	-	1,004
1955	2,749	135,510	149,082	406	426	96	14	942
1956	2,672 ^{c/}	474,000 ^{c/}	153,914	543	527	51	12	1,133
Total	8,321	776,149	452,836	1,691	1,654	343	28	3,716

a/Studies performed before creation of Institute of Malariology, data of slides not available.

b/Increase due to additional slides collected under surveillance operations in various ostanis.

c/Also 71 tribal groups with 1,463 persons not included in the figure.

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Table 3 Training Activities on the Institute of Malariology (1952-1957)

Number of courses given and trainees enrolled

Type of training	1952		1953		1954		1955		1956	
	Cour- ses	Train- ees	Cour- ses	Train- ees	Cour- ses	Train- ees	Cour- ses	Train- ees	Cour- ses	Train- ees
Epidemiology	-	-	-	-	-	-	1	4	1	3
Malariology	1	32	1	45	1	25	2	37	1	30
Entomology	1	10	-	3	-	3	1	10	1	8
Technology	1	8	1	2	1	9	1	12	1	10
Chief of operation	-	-	1	31	-	-	-	-	-	-
Microscopist	-	3	-	3	1	6	1	8	1	10
Insect collector	1	10	1	15	1	22	1	14	1	18
Surveillance agent	-	-	-	-	-	-	4	54	8	316
Sanitary aid	1	24	1	34	1	54	1	58	1	62
Statistician	-	-	1	7	-	-	-	-	-	-
Practical & field training	-	-	1	142	-	-	-	-	-	-
Total	5	87	7	282	5	119	12	197	15	457
Grand total	44 courses				1142 trainees					

27. During this period (1952-1956 inclusive) the staff of the Institute of Malariology was increased from 25 in 1952 to 267, including 52 epidemiologists, entomologists, technologists and chemists. Similarly, the staff of Malaria Control Service was enlarged from 100 in 1950 to 1,834 in 1956. This expansion in the number of personnel was due to the introduction of surveillance operations and stabilization of squad leaders taken into the service on a permanent basis.

28. During the period 1950-1956 inclusive a total of US\$10,866,490 were spent on malaria control (including survey, research and training). Of this figure \$385,000 was supplied by UNICEF, \$6,230,000 by the United States Agency for International Development, \$73,158 by WHO and the rest by the Government.

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General achievements during the control period

29. During the period 1950-1956 inclusive, several important achievements were made in the anti-malaria campaign:

- a) The anti-malaria service had developed into an independent organization with regionalized malaria offices fully equipped with the necessary supplies, transport etc. The existing technical personnel were, if not sufficient in number, of the highest quality and devoted to their task.
- b) The Institute of Malariology had greatly expanded its activities and, in addition to completing malariometric and entomological maps of the country and training 1,142 personnel for survey and control operations, had started more intensive research on nomadism and other entomological problems, such as the biology and ecology of vectors and an evaluation of the residual effect of new insecticides.
- c) The spraying techniques and equipment had been standardized and the per capita cost reduced. The logistics of the programme had been developed to meet the requirements of such an important nationwide operation.
- d) Surveillance operations were taking shape: sub-professional staff had been recruited and specially trained for this purpose.
- e) Regional laboratories were being established in order to decentralize the checking of slides.
- f) The maintenance of vehicles had been streamlined and decentralized.
- g) Every person working in the programme had received special training for his job.
- h) Reporting and statistical analysis had been improved.
- i) The administrative procedures, although slow and sometimes cumbersome because of laws and regulations, had been standardized, and - most important of all - 19,427 villages were under active spraying and 4,558,700 persons were being protected. In addition, in 4,115 villages throughout the country, transmission had been completely interrupted and surveillance established (see Map 1 below). The DDT spraying was working very well and, with respect to the objective of control, most of the technical problems had been overcome.

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30. On the operational side, however, there were numerous problems delaying the progress of the programme or reducing its efficiency. Among these were the geographical situation of the country; the lack of sufficient motorable roads and of other adequate communications; the scanty health education of the public; problems related to the type of houses and other construction (too high ceilings or inaccessible animal shelters); and a number of agricultural practices such as silk worm cultivation in the north.

31. On the administrative side, a major problem arose in 1956 when financing of the programme became the responsibility of the Plan Organization. Prior to that time, in the period 1953-1956, funds were obtained according to the financial regulations of the Public Health Co-operative Organization. These regulations were quite flexible and caused no major difficulty. From 1956 onward, however, the financial rules and regulations of the Plan Organization were applicable also to the malaria programme, and the system of pre-audit in addition to post-audit greatly retarded the campaign. The regulations in connexion with the hiring of personnel and the procurement of supplies and equipment were also most inconvenient. These administrative difficulties were so great that the programme threatened to come to a standstill. Personnel were leaving the Organization on account of low pay, and no new personnel could be attracted to the Malaria Service. The situation with respect to supplies and equipment was equally serious until the Government realized the deficiencies and took major steps to remedy the difficulties.

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Malaria programme in Iran

Map 1. Areas under malaria control, 1956 and 1957



Areas Under Control



Areas Under Surveillance



Shift from malaria control to eradication in Iran

32. No country can afford to continue with the control of malaria even though apparently the cost in any one year does not seem very high. The magnitude of the organization required for such a programme, even of the control type, is so great that sooner or later it would fail to achieve its ends either on account of diversion of interest of the health authorities to other health problems, or because of a reduction of the general budget, in which case the malaria programme would be the first to suffer.

33. In the light of the achievements in the malaria control period (although not yet consolidated), with the new strong anti-malaria service in which every move was standardized and streamlined and its personnel fully trained, and in view of the tremendous expenditures already made and the important improvements brought about in the health and working power of the people in agriculture and industry, the wisest step to be taken by the Government was to agree upon a programme for the eradication of malaria. This programme began in 1957 with the co-operation of UNICEF and WHO. The Government earmarked 980 million Rials (equivalent to US\$13.1 million) for the local costs of the five-year programme. UNICEF agreed to provide \$3.2 million for imported equipment, supplies and transport, and WHO supported the project with its technical guidance, assigning advisers and providing fellowships. Although the United States Agency for International Development had reduced its financial support in 1955, it continued to give technical advisory service and fellowships.

Malaria eradication: the first five years

34. The tripartite agreement for malaria eradication was signed by the Government, UNICEF and WHO in 1957, to cover a period of five years, 1957-1962. For this purpose several administrative and organizational changes were made in the Malaria Eradication Service. An independent department of health, entitled the Malaria Eradication Organization, was established in the Ministry with a Director General in charge and with the following divisions:

- a) The Division of Medical Services, to which all mobile epidemiological teams and field protozoology laboratories of the Institute of Malariology were transferred in order to carry out their duties on a decentralized basis in the ostan and shahrestans.
- b) The Division of Field Operations for the implementation of spraying and surveillance operations in the field.
- c) The Division of Administration with all its necessary sections.

At the same time, the organization was decentralized down to the ostan, shahrestan, bakhsh and dehestan levels, creating a network of health personnel covering all those parts of the country which had been taken under eradication.

35. The Institute of Malariology was relieved of its operational responsibilities during this period in order to permit it to concentrate on research in various problems of the epidemiology of malaria in its static and dynamic stages, in technical problems of eradication (ecology and biology of vectors, resistance, nomadism, evaluation of insecticides etc.), and on the training of technical personnel.

36. The Scientific Council continued to be the supreme technical advisory body of the eradication programme and to meet once a month. In 1960 it appointed a special subcommittee on planning and evaluation, which meets regularly to discuss and evaluate various problems, and reports when necessary to the Council.

37. In view of the size of the country, the different stages of advancement of the control operation in various ostan and shahrestans, and, finally, in view of financial limitations, the eradication programme was planned in four stages and the country divided into four zones (see Map 2 below). Zone 1 covered the Caspian and West Azerbaijan areas where the control programme was already far advanced, and this zone came into the malaria eradication phase in 1957.

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38. According to the plan, as each zone entered the eradication stage, the spraying and surveillance activities would be continued in the sectors previously sprayed. However this zoning had to be changed in the following year because of appearance of resistance to DDT in A. stephensi in the south in the autumn of 1957. In view of the epidemics threatening the south and the change of susceptibility of this vector to DDT and finally owing to the fact that the majority of the southern areas affected was already under operations for several years, it was decided to change the zoning and to advance the programme in the southern zone (see Map 3 below), which at the time of the original planning was left to be covered in 1960 in order to allow sufficient time for studies of problems associated with the tribal people, the short residual effects of insecticides on the walls, the outdoor resting habits of A. fluviatilis and other entomological and social factors.

39. Malaria epidemics which occurred in the south of Iran in the autumn of 1957 diverted the full attention of the organization from the normal activities of the preparatory phase, including geographical reconnaissance in other zones. However this programme was soon developed after three experiments conducted in Kazeroun, Jahrom and Birjand for the standardization of methods and procedures. In 1960, 4,427 villages were protected and in 1961, 12,797 villages. In areas already under spraying and surveillance the deficiency in coverage was found to be only about 8 per cent.

40. During the years of control operations, when DDT was used in southern Iran, particularly in the years 1955 and 1956, the density of A. stephensi was gradually reduced to a very low level, even to near zero in Khouzistan Plain. In that period the trend of susceptibility of A. stephensi to chlorinated hydrocarbons was apparently normal and the LC50 was estimated as 0.66 for DDT and 0.18 for dieldrin (according to Busvine-Nash and WHO methods).

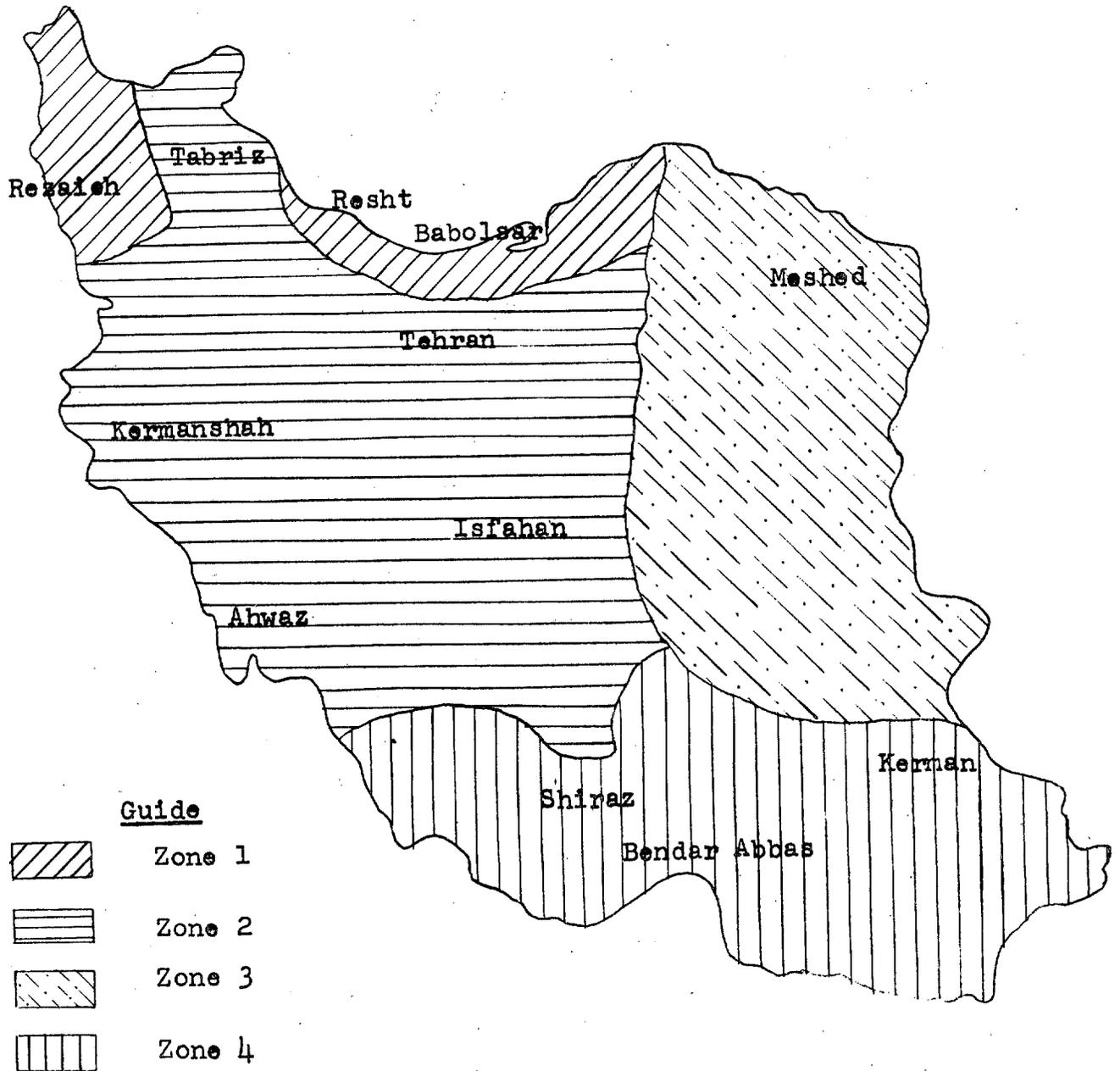
During the early autumn of 1957, when the hot months of summer ended, the density of A. stephensi began to rise considerably and a DDT-resistant population grew up. This situation, in addition to the climatic conditions, led to important outbreaks of malaria in many parts of the southern plains. Susceptibility tests carried out on A. stephensi in various areas revealed the existence of foci of highly DDT-resistant mosquito, unevenly distributed all over the south (see Map 4 below), but susceptible to dieldrin. DDT was then replaced by dieldrin, applied in two cycles a year; this resulted in a great decrease in transmission, the complete disappearance of A. stephensi in Khouzistan Plain and a decrease to nearly zero in other areas.

41. This apparent control over the A. stephensi gave the Malaria Eradication Service time to devote more attention to the organization of the campaign in other zones, and the Institute of Malariology expanded its work at the Kazeroun Research Station to study new problems created after the development of resistance.

42. In 1958, the programme of eradication was extended to cover the western part of Zone 2 and all of Zone 4. The revised plan is shown in Map 3 below. In 1959 the eastern part of Zone 2 (which became Zone 3 under the revised programme) was added to the programme. The last Zone which was to have been covered in 1960 (Zone 4 of the revised plan) did not receive full coverage until 1962 because of weaknesses in the preparatory operations in that area and of the financial shortcomings of the programme. The low density or even the absence of A. stephensi (by hand capture) remained the same up to 1959, and A. stephensi could not be collected in any areas in the south except in unsprayed villages and areas where one single spraying was performed in the spring of 1958. Susceptibility tests performed in this period with dieldrin-impregnated papers resulted in a 100 per cent kill in villages which had never been sprayed but showed only a 78 per cent kill with 4 per cent DDT, a sign of natural resistance to DDT.

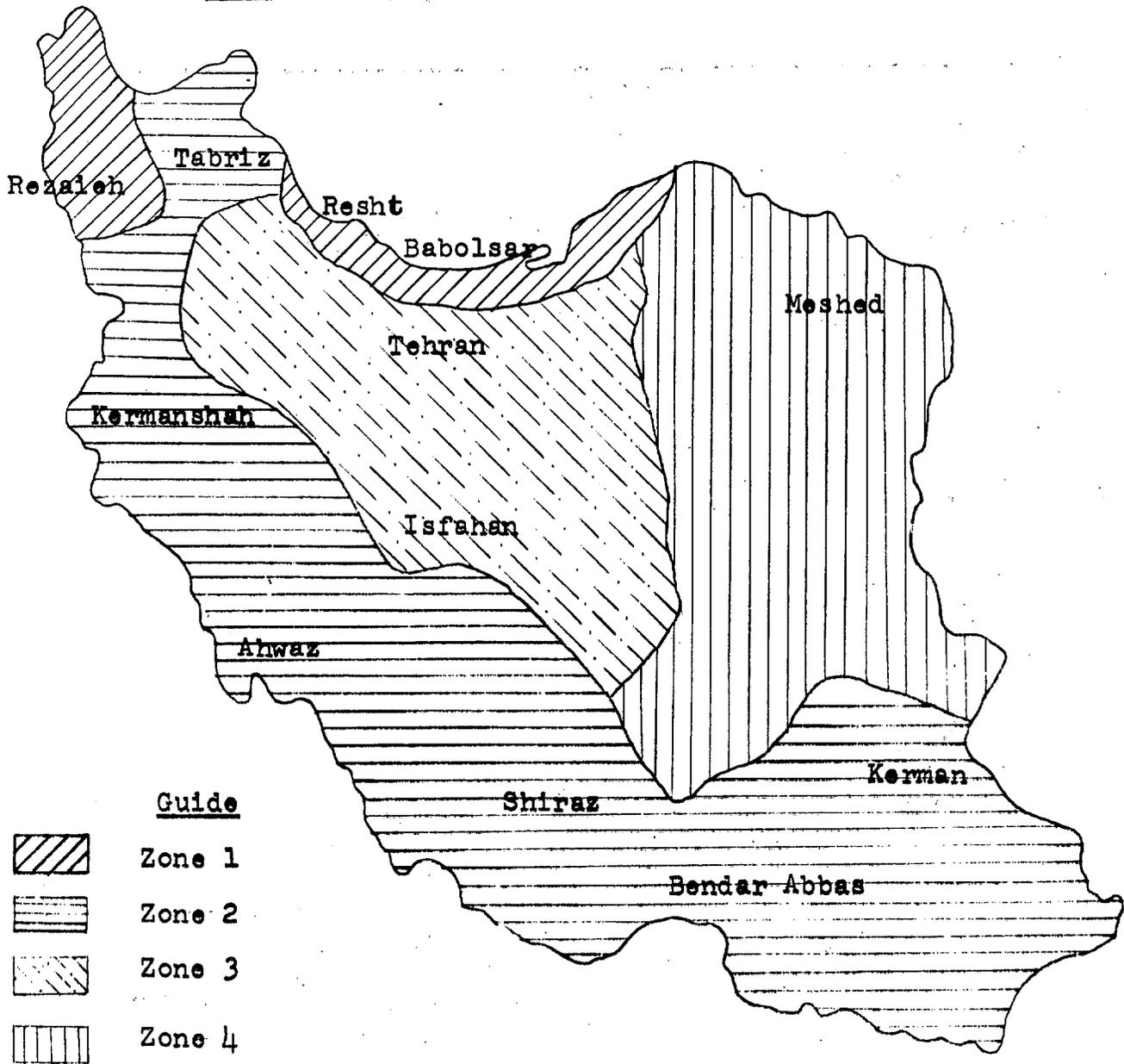
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Malaria eradication programme in Iran
Map 2 Malaria eradication zones in 1957



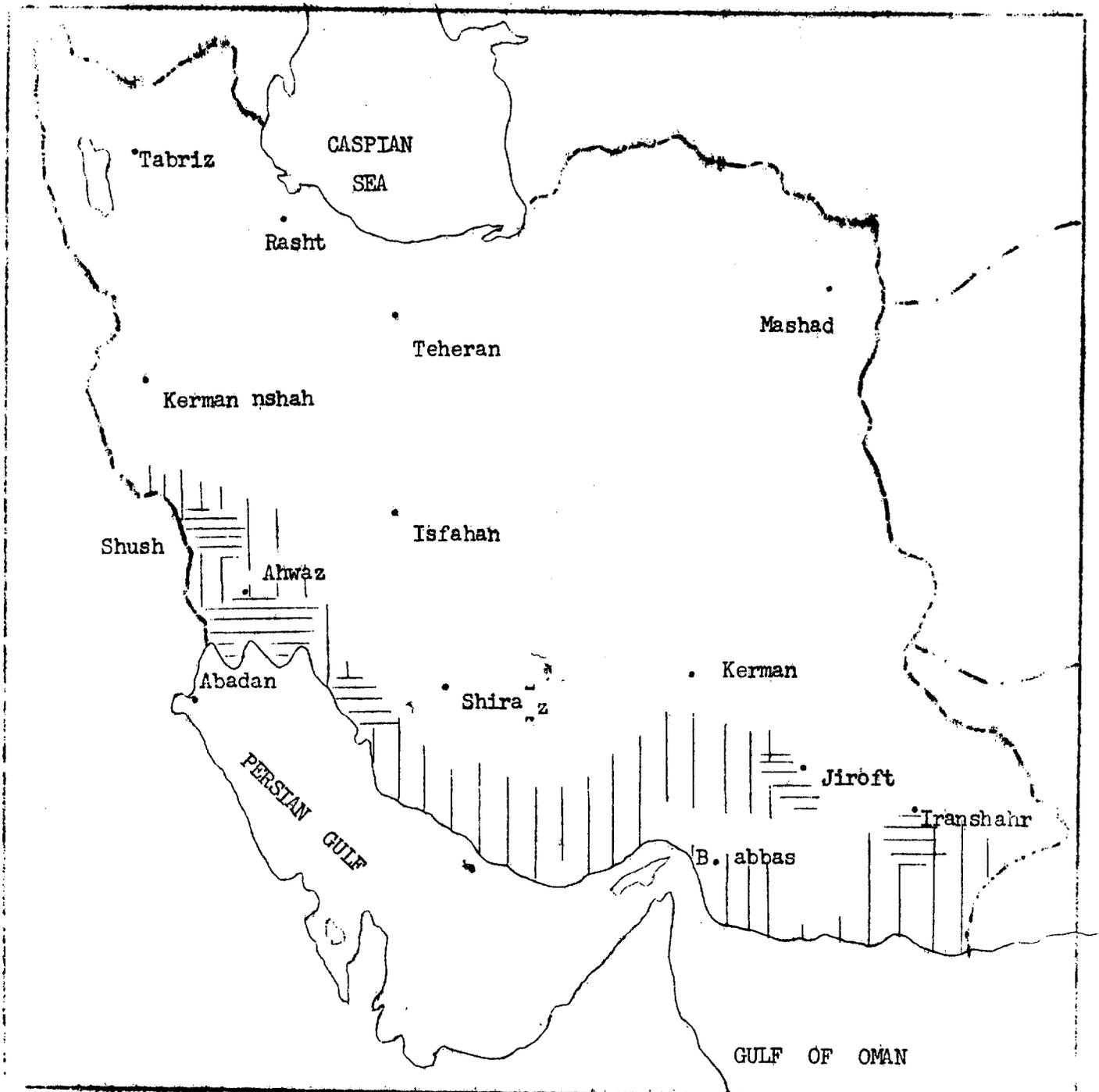
Malaria eradication programme in Iran

Map 3 Malaria eradication zones in 1958

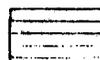


Malaria eradication programme in Iran

Map 4 Areas with resistance of *A. stephensi* to DDT, 1957-1958



Area of low or intermediate resistance



Area of High resistance

43. From mid-1959 (after spraying), the dieldrin-resistant vector appeared in the Balutchistan and Kerman areas. Tests performed later showed very low vector mortality even after 24 hours contact with highest concentration of dieldrin. From then up to the spring of 1961 the area of distribution of dieldrin-resistant A. stephensi was extended gradually, to east Fars (late 1959), west Fars (mid-1960), east Khouzistan (late 1960) and then to the Khouzistan Plain (in 1961). As susceptibility tests performed in these areas showed a very high degree of resistance to dieldrin and a lesser degree of resistance to DDT, a shift was made back to the use of DDT (first in Kerman and Balutchistan, then in Fars and later on in Khouzistan). However, the use of DDT led again to high resistance to DDT so that spraying was completely stopped in the A. stephensi area of the south and even in Khouzistan Plain, where, although DDT still appeared partially effective, it was thereafter applied only as an emergency measure in case of outbreaks.

44. Throughout the first five years, DDT was used in all northern ostan and sometimes in the south. Dieldrin was used only for four years and stopped after resistance appeared in all areas of distribution of A. stephensi. In one experimental area of Kazeroun Station, BHC was used for an evaluation of its residual effect. Table 4 below shows spraying operations during this period.

Table 4 Spraying operations 1957-1961

		No. of villages sprayed	Population protected	No. of premises sprayed	Insecticides used			
					DDT 75%	DDT 100%	DLD	Gamexane
		- in thousands -			+ thousands of kilogrammes -			
1957	-	24.3	5,770.5	1,026.8	1,164.1	3.4	-	-
1958	Spring	26.1	5,729.1	1,109.6	904.1	3.3	76.0	.8
	Autumn	8.0	1,404.2	276.2	.8	.8	71.7	-
1959	Spring	26.4	5,650.9	1,192.5	926.8	2.2	88.8	1.5
	Autumn	8.2	1,462.9	449.6	43.7	-	46.9	.4
1960	Spring	27.5	5,693.0	1,302.6	1,113.1	3.3	37.8	1.5
	Autumn	8.9	1,280.5	464.6	44.6	-	24.6	.1
1961		26.3	5,292.5	1,113.5	1,081.9	2.5	5.9	.6

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45. The extent and activities in respect to surveillance operations in this period are shown in the following table:

Table 5 Surveillance operations 1957-1961

	Type of surveillance	Extent of surveillance		Slides collected			Positive slides			Percent of slides collec.
				- in thousands -			- in thousands -			
				0-2 years	2 years & over	Total	0-2 years	2 years & over	Total	
1957	10% 100% attack 100% consol. Total	15.8	4,218.5			448.6			7.4	10.6
1958	10% 100% attack 100% consol. Total	2.1 7.3 10.4 19.9	573.3 2,075.9 2,815.9 5,565.2	73.9 113.9 34.5 222.3	16.5 88.9 118.4 223.9	90.5 202.7 152.9 446.1	- - - -	- - - -	.8 2.8 .9 4.4	15.8 9.8 5.4 8.0
1959	10% 100% attack 100% consol. Total	1.9 10.8 15.2 27.9	495.7 2,561.5 4,621.5 7,680.7	65.9 195.7 40.2 301.8	15.7 173.5 234.8 424.0	81.5 369.2 275.0 725.8	.2 .9 .3 1.5	.4 2.9 1.7 4.9	.6 3.7 2.0 6.4	16.5 14.2 5.9 8.4
1960	10% 100% attack 100% consol. Total	1.5 18.6 14.1 34.3	417.2 4,358.9 4,579.7 9,355.8	71.3 199.0 99.4 369.6	45.1 626.6 325.9 997.5	116.4 825.5 425.2 1,367.1	.7 1.2 .4 2.3	2.0 4.3 1.2 7.4	2.7 5.5 1.6 9.7	27.9 18.9 9.3 14.6
1961	10% 100% attack 100% consol. Total	1.9 10.8 18.6 31.3	426.2 3,176.8 5,256.0 8,859.0	- - - -	- - - -	212.2 298.1 725.8 1,236.1	- - - -	- - - -	3.4 1.9 .5 5.0	49.8 9.4 13.8 13.9

46. Epidemiological evaluations were made throughout the country according to international standards, to evaluate the efficiency of the spraying, determine the interruption of transmission, and to indicate the advisability of discontinuing spraying in any area. Under surveillance, each village will be visited by a surveillance agent once a month, and in the epidemic areas once a fortnight. The surveillance work will be supported by a network of laboratories, epidemiologists and entomologists who will perform epidemiological investigations and give radical treatment to detected cases. It has been possible to interrupt spraying progressively in many areas, and, by the end of 1961, out of a total of 31,252 villages under surveillance, 18,576 villages with a population of 5,255,983 were under consolidation while 10,759 villages with 3,176,788 people were in the advanced attack phase. Table 5 above shows the extent of surveillance operations during the period 1957-1961. Although attempts to develop passive case detection by the health units and volunteer collaborators were unsuccessful, the activated passive surveillance through the assignment of surveillance agents to dispensaries gave very good results.

47. The progress of eradication was hampered in many instances by local technical problems. It was the responsibility of the Institute of Malariology to investigate these problems, to find the cause and if possible the remedies. For this purpose, the Institute created eight research stations in various parts of the country where technical problems existed. One of the important problems in the south is the special behaviour of A. fluviatilis.

48. Studies performed in different areas of the normal distribution of this anopheles (both unsprayed and sprayed areas), showed A. fluviatilis as a "medium stable" vector, moderately anthropophilic (average index 30 per cent) and with exophilic tendency. Collection of this anopheles from indoor shelters (rooms, stables, huts etc.) by the total catch method (using aerosol spraying) showed that 40 to 85 per cent (according to the conditions) rest outdoors. This may change according to the seasonal activity and indoor and outdoor temperatures.

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49. The female of A. fluviatilis, at different stages of blood digestion, development of ovaries and gonotrophic cycles (females of dangerous age) were found in natural outdoor shelters or artificial shelter pits. The exophilic character of this anopheles is determined by the resting and sleeping habits of the people during six to eight months of the year.

50. While A. fluviatilis was found susceptible to both DDT and dieldrin its control could not be maintained for a reasonable period of time.

51. The role of A. fluviatilis as a vector of malaria has already been proven, either by conformity to the human blood parasite index (where this anopheles is the only or predominating species) or by the presence of sporozoite in her salivary glands.

52. These studies have shown that this anopheles is a medium stable vector, controlled if a high or moderate per cent daily mortality is established. Unfortunately this could not be obtained because of the natural and partial exophilic and secondary exophagic character of the anopheles and, if attainable, would be only of a long lysis type.

53. Another problem studied was the cause of change in the resting habits and secondary exophilia (acquired trait of behavioural resistance), in A. (M.) superpictus.

54. Since the introduction of residual spraying in the north-eastern area of Iran (north Khorassan) in 1954, and after several years of DDT application, malaria transmission was interrupted in many parts of this area. The interruption in this area has been maintained except in two or three small foci, where, after reduction of the number of malaria cases and apparent interruption of transmission, it was found that either the transmission of malaria had remained or had been re-established. Studies performed during 1960-1961 showed that besides operational deficiencies such as lack of total coverage in time and in space (because of newly built houses or temporary tents or shelters), A. superpictus

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has a partial tendency to rest outdoors, although in other areas it was found to be a strictly endophilic and endophagic vector. During these studies, A. superpictus was found with a reasonable population and in different stages of blood digestion, development of ovaries, gonotrophic cycles and even with sporozoite in the salivary glands in outdoor shelters namely caves, along the stony valley of Kashafroud River. After this observation, a pilot area was selected and the spraying operation was coupled with prophylactic drug distribution. The method worked satisfactorily and in 1961 the Malaria Eradication Organization expanded this method throughout this and similar areas.

55. Further studies are being made on each anopheline vector, particularly A. stephensi, or various methods of case detection, and on the administration of drugs (chloroquinized salt e.g. among nomadic tribes), the residual effects of DDT, dieldrin, diazinone, malathion emulsifiable concentrate, BHC and others.

56. Another activity of the Institute is the training of newly recruited staff and the reorientation of senior staff in new techniques and new discoveries in the science of malariology and malaria eradication. Table 6 below shows the training activities of the Institute during the period 1957-1961. Public health education is an important part of the educational activities of the Malaria Eradication Service; it is carried out by all field personnel and co-ordinated by health educators trained specifically to work in malaria eradication in each ostan.

57. Finally, great emphasis is given to the co-ordination of the Iranian campaign with those of the neighbouring countries through international or intra-regional meetings. Co-ordination with Turkey and Pakistan is maintained through CENTO,^{1/} and with Iraq through regional meetings or special border meetings organized with the assistance of WHO to meet every six months. The directors of the campaign have also visited other neighbouring countries (Afghanistan and Russia) to exchange information.

^{1/} Central Treaty Organization.

Table 6 Training activities of the Institute of Parasitology and Malariology, 1957-1961

P - Periods
Gr- Graduates

Type of training	1957		1958		1959		1960		1961		Total	
	P	Gr.	P	Gr	P	Gr.	P	Gr	P	Gr	P	Gr
Epidemiologists	-	-	-	-	-	-	-	-	-	-	-	-
Malariologists	1	14 ^{a/}	1	8 ^{a/}	1	8	1	6	2	23 ^{a/}	6	59
Entomologists	-	1	-	1 ^{a/}	-	a/	-	3 ^{a/}	-	-	-	5
Technologists	1	20	1	33	-	4 ^{a/}	1	27 ^{a/}	-	2	3	86
Chief, field operations	-	-	2	100	1	66	2	37	1	24	6	227
Malaria microscopists	1	54	2	108	1	50 ^{a/}	1	62	1	61	6	335
Insect collectors	1	32	-	-	3	29	-	-	1	6	5	67
Surveillance agents ^{b/}	8	321	1	23	9	517	2	232	2	218	22	1311
Sanitarian aids ^{c/}	1	49	1	46	1	43	1	48	1	50	5	236
Statistical clerks (shahrestan) ^{b/}	-	-	-	-	1	131	-	-	-	-	1	131
Statistical clerks (ostan) ^{b/}	-	-	-	-	1	40	1	27	1	33	3	100
Geographical reconnaissance	-	-	-	-	-	-	4	134	3	85	7	219
Statistics as applied to malaria and medical research work	-	-	1	25	1	20	-	-	-	-	2	45
Orientation courses	-	-	-	-	4	45	1	25	1	25	6	95
Totals	13	491	9	344	23	953	14	601	13	527	72	2916

^{a/} In-service training.

^{b/} With the assistance of the Malaria Eradication Organization.

^{c/} Teaching of malaria and other endemic diseases at Palasht School of Sanitation.

58. Fellowships granted by WHO and by the United States Agency for International Development have given several senior staff of the programme an opportunity to visit eradication operations in different countries or to meet their colleagues in malaria eradication training centres in Jamaica and in Yugoslavia.

59. Iran has offered its facilities to many directors and senior staff of eradication programmes of various countries. The staff of the Malaria Eradication Organization was increased from 1,834 (with 2 malariologists and 10 engineers) in 1957 to 3,359 (with 44 malariologists and 24 engineers) in 1961. The staff of the Institute of Malariology remained almost unchanged. Every effort was being made to complete the staff of the Malaria Eradication Organization and every trained person has been put at the disposal of the Organization.

60. During the period 1957-1961, a total of 1,558 million Rials (US\$20,779,712) was spent on the programme. UNICEF contributed about US\$4.9 million for imported transport, insecticides, spray pumps, laboratory equipment and anti-malaria drugs. A UNICEF transport officer was stationed in Teheran in this period to assist in the operation and maintenance of vehicles.

61. WHO assistance included provision of advisory service, fellowships and partial contribution in the payment of key personnel salaries. The latter amounted to \$249,288 during 1958-1962 and helped the Malaria Eradication Service greatly to keep the senior staff on the job and not lose them to better paid positions in other ministries and private organizations.

62. The United States Agency for International Development has assisted the campaign by assigning a malaria adviser to it and, since 1960, three malaria specialists as well. It has also provided fellowships for senior staff members of the Organization and of the Institute.

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63. One of the most striking features of the campaign during its first five years is the fact that the Government has increased its support for the campaign by about 30 per cent over its original commitment. Certain administrative problems persisted, however. The pre-auditing and post-auditing have continued and other rules and regulations of the Plan Organization have affected the salary of the staff and the timely provision of equipment and supplies.

Achievements of the first five years of malaria eradication

64. In addition to the full development of the various services of the Malaria Eradication Organization at each level, and of the Institute of Malariology at its Headquarters and research stations, progress was made in two important areas during the period 1957-1961:

- a) Eradication of malaria has been realized in a great portion of the country, that part which has the highest agricultural and industrial potential. By the end of 1961, 31,252 villages were under surveillance, of which 18,576 villages with 5,255,983 inhabitants were already under consolidation. An area of 2,500 villages in the Teheran Plain is large enough to be transferred to the maintenance phase signalling the end of eradication according to WHO standards. Of 26,299 villages under spraying 10,759 with a population of 3,176,788 were under advanced attack (see Map 5 below). Geographical reconnaissance had been completed in 24,224 villages and maps made of all villages under spraying and surveillance. In the north (Caspian), where labourers had been imported by the landowners, new malaria foci developed in the areas which had been cleared, and it was necessary to take special measures.
- b) A better knowledge of the basic epidemiology of malaria in its static and dynamic forms has been gained, facilitating the sound and logical planning and zoning of the country. The network of eight research stations and numerous entomological collection posts, organized in the south or in other strategic areas, have improved the forecasting of trends and developments and made it possible to take preventive measures.

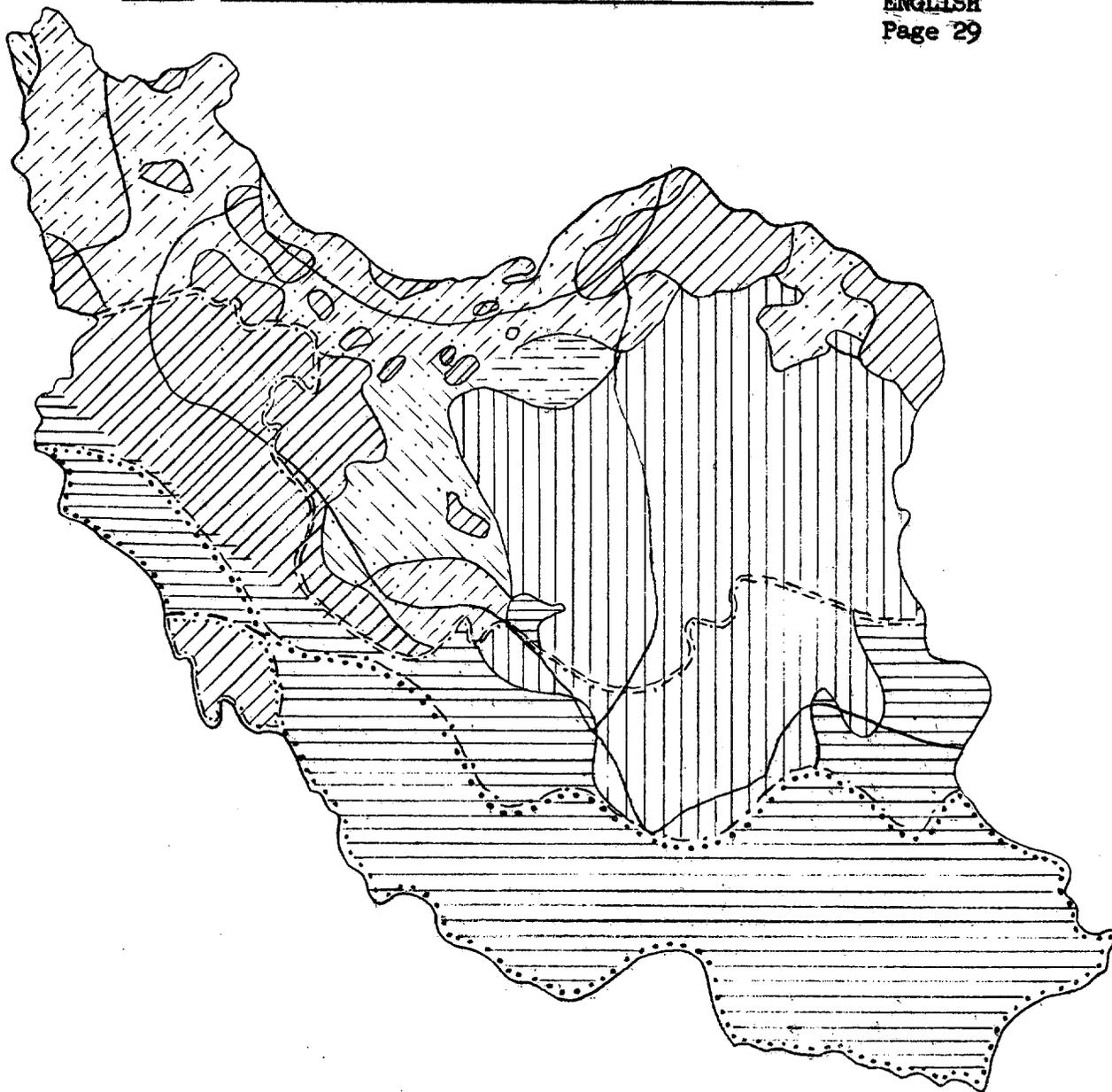
Malaria eradication programme in Iran

Map 5 Plan of operation in the provinces in 1961

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Areas Under Spraying and 10% Surveillance

Areas Under Spraying and 100% Surveillance

Areas of Spraying interruption Under 100% Surveillance

Areas of Basically Clean Under 10% Surveillance

Areas of Basically Clean Under 100% Surveillance

Areas Under Study

Boundary of North and South Zones

Refractory

Responsive



The second five years of malaria eradication

65. The second five-year malaria eradication plan covers the years 1962-1967. Under the tripartite agreement signed by the Government, UNICEF and WHO, the Government has undertaken to provide almost 3,437 million Rials (US\$45,823,000) for the implementation of the campaign in this period.

66. The plan differs from the previous one in the following ways:

a) Because of the development of double resistance of A. stephensi to DDT and dieldrin in the south, consideration is given to a more practical basis of zoning. In view of the above and because of socio-geographical and technical problems, the country is divided into two main zones:

- i) The Northern Zone has a population of about 16,824,000 inhabitants in 40,348 villages. Of this population 5.1 million live in cities and large towns. Malaria is generally unstable throughout the zone and responsive to DDT spraying except in areas where A. superpictus has developed outdoor resting habits. In the deep forests of the Caspian areas total coverage has been retarded because of inaccessibility for spraying. Studies will continue in the Shahsavār Station, which was organized specifically to study forest malaria, the entomological infection potential of the areas under consolidation and trends following the introduction of malaria carriers into the area. Finally, two important dam construction sites and many large road developments have attracted hundreds of labourers from other areas.
- ii) The Southern Zone has 16,055 villages with 4,470,000 inhabitants, and is divided into two areas. The non-stephensi area covers both slopes of the Zagros Mountains; here the main vectors are A. fluviatilis and A. superpictus. Malaria transmission has not been interrupted because of the difficulty in achieving total coverage, the outdoor resting habits of the vectors, the movements of tribes and the absence of communications. The stephensi area is in two parts. In Khouzistan and the south-west corner of Kermanshah A. stephensi disappeared during the period 1955-1956 and 1958-1961 and the programme was close to final success when resistance to DDT and dieldrin was followed by epidemics, the infection having been imported by labourers and workers from the mountainous areas of Khouzistan or by visitors from the plain. In the areas of Fars, Kerman and Balutchistan A. superpictus and A. fluviatilis are the vectors in the north and A. stephensi in the south. In Balutchistan

A. culicifacies is also a vector. The area is inhabited by numerous tribes and inhabitants live in various types of shelter including huts and tents. Total coverage and complete interruption of transmission were not possible even when A. stephensi was susceptible to the two chlorinated hydrocarbons. Numerous studies are going forward at the Kazeroun Research Station on the ecology of the vectors, the use of medicated salt, and on the biochemical and toxicological aspects of organo-phosphorous insecticides and carbamates. In the Fasa project, full-scale malaria eradication techniques are being implemented.

- b) The second main feature of the current plan is the great importance given to the basic health network, the future of eradication operational personnel etc. Provision is made for the establishment of malaria posts if the basic health service is slow in its development.
- c) The plan emphasizes research into various problems connected with malaria eradication.
- d) Comprehensive health training is provided for the field staff in the areas of advanced eradication. All of Zone 1 is covered by the conventional malaria eradication programme, while Zone 2 has a control programme to ensure the maintenance of previous achievements as the pre-eradication activities go forward in the hope that new ways and means will be found through national and international research. Geographical reconnaissance is also being carried out in areas not yet covered.

67. Special emphasis will be given to the elimination of foci in the consolidation areas. Two special evaluation teams are actively working on this type of problem in Gorgan and Mazandaran, and another is studying the causes of non-interruption of transmission in Kermanshah.

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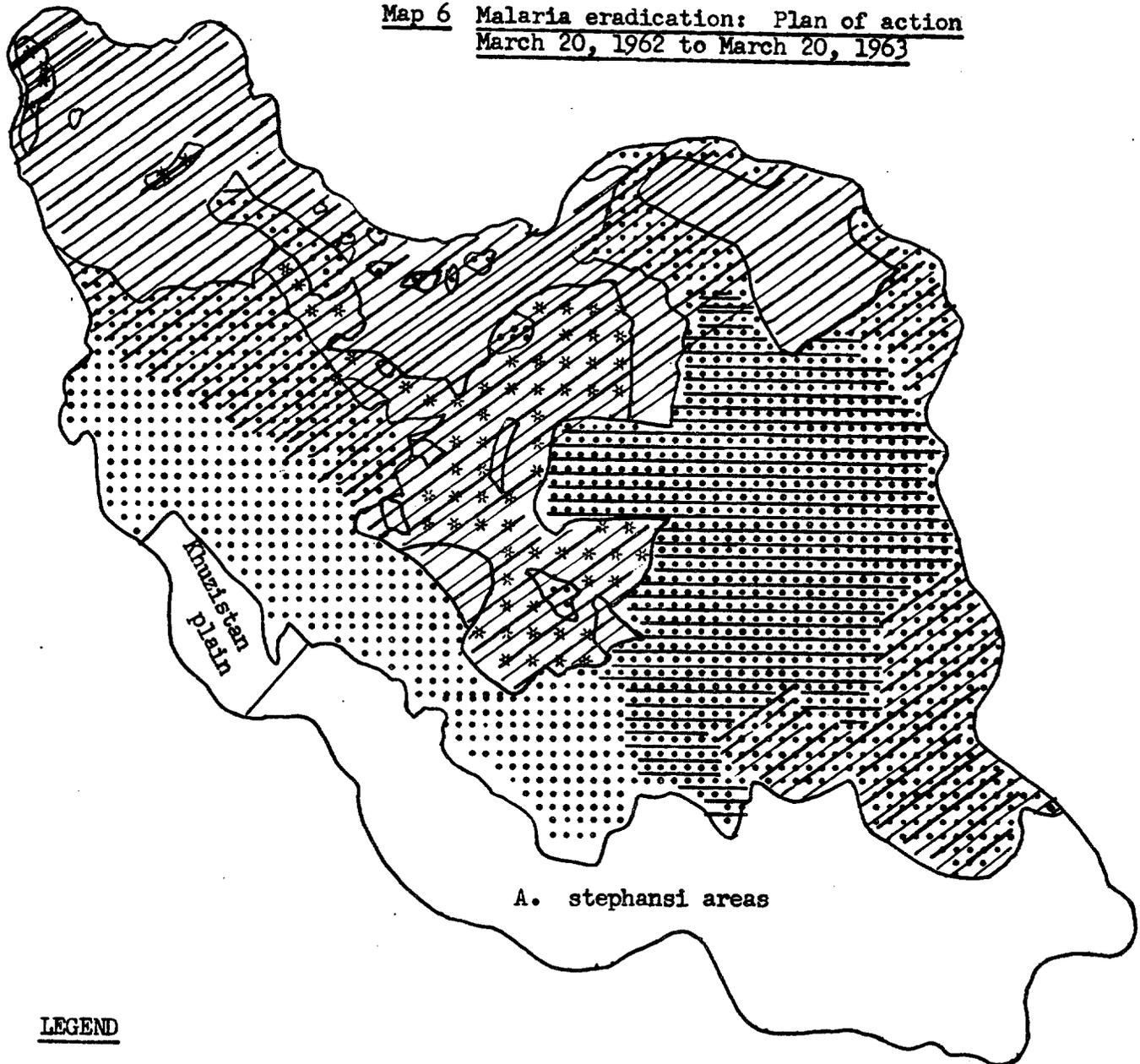
68. In the course of 1962 a total of 32,490 villages were sprayed and 5,596,044 persons protected. Larviciding covered five main cities and their suburban areas. Surveillance activities covered 7,472,061 persons under active and 5,353,935 people under passive case detection. In Zone 1, 1,312,707 slides were collected or received from various sources, including 2,753 positives. During the same period 112,552 slides were obtained from the southern area revealing 1,985 positives.

69. In the South the special teams, the malaria posts and the governmental health units have administered primaquine, amodiaquine, camofrim, and chloroquine and pyrimethamine to prevent serious outbreaks. During 1962 seven out of ten residual foci of infection in the Caspian Region were cleared out and only three foci remained active, because of the outdoor resting habits of the vector in one instance (Lowshan), the expansion of cotton cultivation and the arrival of new labourers in the second (Bandpey) and the movement of Turkeman nomads in the third (Maraveh Tape). In these three areas 133 villages in the basically clean areas were found to be infected. Transmission was interrupted in the majority of areas under early attack. Two resistant foci in the areas of advanced attack remained active and required special attention.

70. Transmission was resumed in Khuzistan in late summer and early autumn in a few villages and in two cities, but was discontinued through bi-weekly case detection and mass drug administration. During this year eleven courses and one orientation course were organized at the Institute in which 441 technical persons participated. The plan of action in 1962 is shown in Map 6 below.

Malaria eradication programme in Iran

Map 6 Malaria eradication: Plan of action
March 20, 1962 to March 20, 1963



LEGEND



Problem areas



Consolidation areas



Problem area:
Advanced attack areas



Basically clean areas



Problem area:
Early attack areas

71. The programme in 1963 followed the same course, differing from the 1962 activity only in that the entomological infection potentials of A. stephensi in Khuzistan was high so that the danger of an important outbreak was foreseen. All efforts of the Malaria Organization, the Institute of Parasitology and Malariology and the National Iranian Oil Company were then mobilized to control the expected epidemic. Bi-weekly active surveillance was carried out with mass drug distribution, intensification of the larviciding programme and encouragement of passive case detection. In spite of these efforts, transmission started in mid-June after many labourers from Bandar Abbas had moved into the area and settled in the palm plantations on the outskirts of Abadan and Khorranshahr. The peak of the summer epidemic occurred in July, then declined and rose again by the end of September. During the summer two villages were experimentally sprayed with 2 and 4 grammes of water wettable powder (75 per cent) for an evaluation of the possible effect of DDT. Susceptibility tests showed a mortality of only 22 to 45 per cent after one hour of contact with 4 per cent concentration impregnated paper and a mortality of 56 to 70 per cent after 24 hours of contact.

72. Abadan suburban areas and villages were sprayed to help offset the lack of total coverage in larviciding and case detection as well as the lack of cooperation of the people in taking the prescribed tablets. Two weeks after spraying was completed, the transmission slowed down. In other areas of the south active drug distribution is carried out by mobile teams, malaria posts and health dispensaries.

73. The Institute of Parasitology, Tropical Medicine and Hygiene has been re-organized following the amalgamation of the former Institute of Parasitology and Malariology with the Chair of Tropical Medicine of the Teheran University School of Medicine under a plan agreed by the Scientific Council of the Institute and the University Council and approved by the Minister of Health. However, the organization of the Malariology Division of the Institute continues on the same basis as in the past to fulfill its responsibilities in the malaria eradication programme.

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Brief review of the epidemiology of malaria in Iran in the light of the control and eradication operations

74. The special topography of Iran greatly influences the malaria epidemiology, the distribution of vectors and the habits of the people, affecting the endemicity of malaria and its stability and responsiveness to anti-malaria measures. The two ranges of Zagros and Elburz divide the country into at least three main geographical areas, as follows:

- a) The Caspian area, with a Mediterranean climate;
- b) The central part, which is temperate or semi-arid;
- c) The littoral of the Persian Gulf and the Gulf of Oman, which is sub-tropical. This includes the alluvial plain of Khouzistan, a geographical continuation of the Mesopotamian area.

75. In the Caspian region, with A. maculipennis typicus and A. maculipennis subalpinus as incriminated vectors, malaria appears in unstable form, and one or two years of residual spraying have brought about the interruption of transmission. Spraying has been discontinued in most parts of this area since 1958, and has been resumed only in a few foci after the importation of malaria by labourers and tourists coming from the south.

76. In the second region, or the high plateau, A. superpictus and A. maculipennis typicus are the basic vector fauna. A. sacharovi is found in spotty distribution but with a regular pattern along the southern slopes of the Alburz range, along the Zagros, and sometimes in the central plain area. Malaria appears in hyper- or meso-endemic form, has a five to six-year cycle, and is unstable, with an index of stability of about 0.5. It does not differ from what is usually reported from north and central Turkey, Afghanistan and probably the southern part of the Soviet Union. The area does, however, have an aspect of the problem or resistant focus, when, owing to special climatological or geo-topographical conditions, the mosquitoes do not rest sufficiently, if at all, on the sprayed surfaces. Although A. maculipennis typicus and A. sacharovi have both shown a certain degree of vigor-tolerance to DDT, increasing to a considerable degree during the pre-hibernation period, these events have not in any way affected the satisfactory results of DDT residual spraying.

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77. In these areas the vector reproduction rate varies with the climatic conditions, the presence and extent of favourable breeding places and entomological infection potentials. Except in limited areas where special local conditions have prevented the interruption of transmission, the eradication programme has progressed successfully in the central region and more than 15,000 villages are already under consolidation.

78. The southern limit of the central plateau, or the Zagros range, however, is a true problem area. In addition to A. maculipennis typicus, A. superpictus, and sometimes A. sacharovi, A. fluviatilis is found; this vector, by virtue of its high anthropophilic and exophilic tendencies, gives a certain stability to malaria, particularly in the valleys of the southern and south-western slopes of this range (see Map 2 above). Similar conditions exist, or, if prophecy is permitted, should exist in the same form in the continuation of the Zagros range into Iraq and Turkey. The problem is further complicated by the fact that this area is inhabited in the summer by tribes who live during the winter in the southern flat or low hilly areas. An area of this type starts from Diarbekr and Siirt in Turkey and passes through Iraq and Iran, ending in Pakistan.

79. Extensive studies performed by scientists of the Institute of Parasitology, Tropical Medicine and Hygiene have firmly determined the role of tribal movements in the change of relationships between the number of mosquitoes and the available human bait, and particularly the availability of large unsprayed resting surfaces (i.e. tents). It has also been demonstrated that the pre-existence of infective carriers in the stable population has a greater effect on the appearance of transmission, because of the usually short stay of tribes at any one point. The difficulty in reaching all inhabited places in these mountainous areas makes the application of residual insecticides and other treatment measures incomplete if not impossible.

80. Finally, the overlapping distribution of the oriental species of mosquito fauna of the third region or the southern littoral zone, namely A. stephensi mysorensis and A. culicifacies, both vectors of epidemic malaria, gives to these foci of the Zagros range the aspect of a reservoir of malaria (see Map 2 above). The appearance of malaria epidemics every five to six years in the southern littoral zone has been recorded. The astonishingly rapid increase of the population of DDT-resistant A. stephensi in the southern littoral of Iran (and Iraq), culminating in important epidemics over this area in 1957, could possibly be explained in the light of the existence of favourable climatological conditions coinciding with the expected epidemic year.

81. It is also interesting to note that A. stephensi disappeared from the littoral plain of Khouzistan late in 1957 when dieldrin was introduced to combat this highly DDT-resistant mosquito, but reappeared again, starting on the slopes of the Zagros range early in 1961, and appeared four months later in the plain as well. The vector density, beginning so low that only a few specimens could be collected by dispensing pyrethrum aerosol, became so high that sufficient numbers could be collected for susceptibility tests. These tests revealed a high resistance to dieldrin. However, the susceptibility to DDT was still sufficient (80 per cent mortality with 4 per cent concentration) for another DDT spraying to be made in 1961 to prevent possible outbreaks, which, according to forecasts, should have occurred in 1962. The anticipated outbreak came late in 1962, when transmission started in a few villages but was overcome with the complete coverage of the population with anti-malaria drugs. In 1963, however, the potentialities of mosquitoes were so high that a very great outbreak could be foreseen. It is due to the great sacrifice and the tremendous efforts of the Malaria Eradication Service and the National Iranian Oil Company that the epidemic potential was kept under control and the number of positive cases did not increase beyond normal expectations.

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82. The picture of malaria in southern Iran is thus complicated by the development of vector resistance, the scanty and dispersed population, the long season of transmission, the outdoor resting habits of the people and their transient living and, finally, by the lack of easy communication with a network of rural health services.

83. At present the research stations of the Institute are carrying out special research projects in this area in order to evaluate the effects of mass drug therapy. Camoprim and medicated salt are distributed as well as organo-phosphorous compounds, and studies of the biology of vector mosquitoes are continuing.

84. The results of a preliminary study of the chloroquinized and daraprimized salt, conducted in 1957-1960, have been very encouraging. Among 190 families (of approximately five persons each) of the Bagdeli clan of Ghashgahi tribes, medicated salt was distributed by agents selected from tribal groups and given training. Total coverage was difficult. At the beginning the people were not appreciative of the effort but became more co-operative after the appearance of protective and curative results and as they were instructed in health education. Blood smears were collected monthly among about 65 per cent of the population. No new cases were observed in those who regularly took salt, but cases occurred in control groups and among those with an irregular intake of salt. The blood of positive cases became negative after three months and remained so afterward.

85. At present this programme has expanded over a large area with 16,000 people (6,000 stable inhabitants and the rest tribal) in the Jareh area. The programme envisages an evaluation not only of the effectiveness of chloroquinized salt, but also of all operational problems.

86. Another research project conducted by the Division of Malariology of the Institute of Parasitology, Tropical Medicine and Hygiene is the evaluation of new insecticides of the organo-phosphorous group (fenthion, malathion) and of carbamates. These insecticides are examined from the point of view of their

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toxicological effects on the spraymen and on the inhabitants of the sprayed villages, as well as with respect to their residual value. Two WHO scientists are collaborating in this project for biochemical and toxicological evaluation.

87. Extensive studies are being made on the biology of vector mosquitoes. In one instance radio-isotope phosphorous (P-32) is being used to tag and study the flight range of A. stephensi and its gonotrophic cycle.

88. Operational research is also being conducted in the Fars area with the assistance of advisers of the United States Agency for International Development, aimed at an evaluation of the effect of proper implementation of all eradication techniques (geographical reconnaissance, the spraying of houses and tents, case detection, radical treatment of cases, follow-up, supervision, recording, reporting an estimation of the cost of operation etc.) to determine whether the transmission of malaria could be interrupted by the reinforced operation.

89. Finally, three research stations and two evaluation teams are actively involved in the determination of technical problems in a few foci of infection and in making an evaluation of control methods.

Future trends of the programme

90. In summary, Iran has many if not all of the problems in the field of malariology. Achievements in the north may be pointed to with some satisfaction, as consolidation has been reached in the largest part of this area (about 15,000 villages with a population of 6 million). An additional 6 million inhabitants live in cities, while 4,966 villages were never malarious or else malaria has disappeared from them without specific anti-malaria measures. In certain areas (owing to the great development of community and land reform and the consequent importation of labour or the movement of population into areas newly freed from malaria), small foci of transmission have appeared here and there and have been countered by epidemiological studies and other preventive measures such as spraying and mass drug therapy.

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91. The southern part of the country remains a problem, but the latest and most advanced methods are already under scrutiny in various research stations. The Government has given great importance to rural and community development in the southern areas. By 1964, the epidemic years (on the five-to-six-year cycle) will probably be a thing of the past, as meanwhile Iran and the world will have found remedies for the special problems existing in the south.

92. Nevertheless, the eradication programme may be considered successful. The most fertile, industrialized, inhabited and developed part of Iran (i.e. the northern zone) is already free of malaria to the largest extent. Malaria in this part of the country is no longer a threat to the lives of children or to the working class and no longer retards the execution of agricultural and industrial development.

93. Table 7 below gives a comparison of the population, the land under cultivation and the amount of harvest of three different areas of Iran, namely Guilan, Khouzistan and Zanzan, over a thirty-year period. The rate of growth has been highest in Guilan, where malaria eradication has been feasible and where transmission was interrupted soon after the beginning of the campaign. The increase of crop production in Zanzan is the second highest; here the eradication programme started much later and part of the area is still in the attack phase.

Table 7

Variation in population, land under cultivation and agricultural output over a thirty-year period in Guilan, Zanzan and Khouzistan

	<u>Guilan</u>	<u>Zanzan</u>	<u>Khouzistan</u>
<u>1926-1933</u>			
Population	360,521	191,957	136,195
Cultivated land (hectares)	100,542	-	93,850
Agricultural output (tons)	213,011	72,130	104,139
<u>1960</u>			
Population	884,804	322,452	250,769
Cultivated land (hectares)	206,767	188,862	142,739
Agricultural output (tons)	402,215	82,345	110,759
<u>Rate of increase, 1933-1960 (approx.)</u>			
Population	2.45	1.67	1.84
Cultivated land (hectares)	2.05	-	1.52
Agricultural output (tons)	1.88	1.14	1.06

94. It will be seen from the table that the output of Khouzistan is almost unchanged although the population and the surface of land under cultivation have increased. The inhabitants suffered from great malaria epidemics in 1957 and 1958 and it appears probable that the 1960 figures show the debilitating results of the epidemics.

95. The comparison of the amounts of land under cultivation in the years 1926-1933 and in 1960 show that of fields smaller than 10 hectares, 42.76 per cent were under cultivation in Guilan in 1926-1933, increasing to 93.13 per cent in 1960. These figures show clearly how the standards of living of the individual peasant have risen.

96. The important health problem of malaria has been used in Iran to sell the idea of public health to the population; the successful achievements in eradication of the disease have inspired the confidence and co-operation of the people in health projects. Already the planning committee of the Ministry of Health is giving major consideration to the integration into the general health services of the malaria eradication personnel in provinces under consolidation, reflecting the advice of the Sixth WHO Expert Committee Report that

"In countries where the public health service is not well developed, the development of an eradication service will be a pattern of an efficient service and will serve as a nucleus around which public health service could be built...." ^{2/}

97. The Institute of Parasitology, Tropical Medicine and Hygiene is planning to organize, beginning in the academic year 1964-1965, a one-year graduate course in tropical medicine and hygiene to train epidemiologists and chiefs of rural health and medical care centres. The course will include epidemiology, statistics, preventive medicine, clinical training with respect to infectious and tropical diseases, methods of laboratory diagnosis, field work in epidemiological investigations and eradication and control operations.

^{2/} World Health Organization, Technical Reports Series 1957, 123: Sixth Report of the Expert Committee on Malaria, p.63.

98. For the first two to three years, it is planned to take only the present malariologists and to give them full orientation in other health matters to enable them to serve as general epidemiologists in the ostans where they were working and where they would continue to work and supervise malaria maintenance activities.

99. It is hoped that the interest of international agencies in the problem of malaria will be continued without reduction, as their interest has given valuable support to the national malaria workers and has helped them in turn to obtain the necessary support from the Government.

100. More than 18,000 villages are now under consolidation. During 1963, 31,200 villages have been sprayed and surveillance activities conducted in 37,400 villages. An amount of about 640 million Rials (including international assistance from WHO, UNICEF and US/AID) is going to be spent by the Malaria Eradication Organization of the Ministry of Health and the Institute of Parasitology, Tropical Medicine and Hygiene under the guidance of the Iranian Scientific Council of Malaria for this important programme. The programme involves more than 4,100 technical personnel, 5,000 temporary spraymen, 860 vehicles working in 13 province centres, 75 district centres with 86 malaria laboratories, 8 malaria research stations and 385 entomological capture posts. This huge programme will continue during the next five years; a sum of 3.43 milliard Rials (about US\$45.8 million) has been earmarked for the purpose by the Government.

101. In conclusion, it should be mentioned that all efforts will be devoted to completing eradication in the northern zone, to organizing a buffer zone between the northern zone and southern zone to prevent the infiltration of malaria to the north and to impose a holding action in the south until pilot projects now under way succeed in determining the recommended methods of attack.

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