Planning a Malaria Control Program for IRAN

By JUSTIN M. ANDREWS, Scientist Director*

Description of Iran. Iran lies between 25° and 40° north latitude and 44° and 64° east longitude. If the country were superimposed on this hemisphere, its northern boundary would be coincident with that of the State of Kansas and would extend south to some 200 miles beyond the most southern point of Texas. It is bounded on the north, in order, by the Russian Caucasus, the Caspian Sea, and Russian Turkestan; on the east by Afghanistan and Baluchistan; on the south by the Gulf of Oman and the Persian Gulf; on the west by Iraq and Turkey.

Persia (Iran) is a relatively large country. Its area is about 628,000 square miles, the equivalent of one-fifth of the area of the United States. It is sometimes compared in extent to the combined areas of all the States of this country east of the Mississippi and north of, and including, Tennessee and North Carolina. From the standpoints of climate and topography, it is perhaps more apt to compare Iran with the combined areas of California, New Mexico, Arizona, and Texas.

The country varies in elevation from the majestic heights of Mount Demavand, extending up to 18,600 feet above sea level, down to the shores of the Caspian Sea, the present level of which is about 85 feet below sea level. The most outstanding physiographic features of the terrain are the mountains and the deserts. Extending east and southeast from the Caucasus along the shores of the Caspian Sea is the Elburz Range. Its southern slope is relatively arid with scanty, scrubby vegetation; the seaward exposure is abundantly watered, richly vegetated, and well timbered. The coastal plain, of variable but not of great width, supports wet-rice cultivation, tea plants, and mulberry trees. The Zagros Mountain Range is not as high as the Elburz but is wider. It lies along the western, southwestern, and southern boundaries of the country. The coastal shelf of the Persian Gulf is even more variable in breadth than that of the Caspian Sea and is not vegetated except where irrigation projects have been developed. Between these major mountain ranges lies a vast plain from 3,000 to 5,000 feet above sea level. The east central portion of this plain is sheer desert, said to be as sterile biologically as the polar ice caps. It is on the irrigated plateau extending from the foothills of the mountains that most of the population of Persia is supported. The only navigable river in the country is the Karun, which flows into the head of the Persian Gulf. In general, drainage is toward the interior of the country, commencing as the collected runoff from the snow-covered mountains into numerous erosive channels which finally coalesce to form small rivers. Most of these end in swamps as they approach the desert area.

The climate varies with latitude and altitude. The southern shore of the Caspian Sea is subtropical without extremes of temperature. Just south of the Elbruz Range there is snow in winter, and in summer the temperature may reach 110° F. The southern part of the country is tropical with warm winters and very hot humid summers. Rainfall is variable but, in general, scanty. On the Caspian littoral it may be as much as 50 to 60 inches per year. Along the Persian Gulf the precipitation is 10 to 15 inches per year and exceeds this slightly in the northwestern section of the country. The remainder of Persia receives from 9 to 10 inches per year.

The country is predominantly agricultural, important products being wheat, barley, rice, beet sugar, tea, dates, figs, citrus fruits, melons, nuts, cotton, silk, wool, jute, lambskins, mutton, hides, tobacco, and vegetable oils. The principal exports are oil (petroleum), carpets, dried fruits and nuts, and tobacco.

The inhabitants are predominantly Aryan, with some mixture of Arab blood. There has never been a census of the population; thus, only estimates of its magnitude are available. It is believed to

* Dr. Andrews is Deputy Officer in Charge of the Communicable Disease Center, Public Health Service, Federal Security Agency, Atlanta, Ga.

total about 16 million persons. Tehran is the largest city, with about 830,000 residents. There are six other municipalities – Meshed, Tabriz, Isfahan, Shiraz, Resht, and Hamadan – estimated to have populations in excess of 100,000 each. Forty-three smaller cities vary in populations from 100,000 down to 14,000. These urban dwellers total a little more than 3 million. In addition, there are some 2 million nomadic tribesmen living principally in the Zagros Mountains and following the grass from one season to the next to pasture their herds of sheep and goats. The rest of the population, totaling some 11 million individuals, live in small villages, averaging about 50 families or a total of 250 persons each. It is in these village populations that most of the malaria occurs.

It seems likely that if the government would conscientiously sponsor a sound malaria control program which would go far to free the villagers of a harassing disease and of the discomfort and nuisance of domestic insects, this might serve to restore some of the lost esteem and to establish faith and confidence in the existing regime so that the citizenry would be more interested in continuing to support a democratic monarchism than in accepting some other political ideology.

Ministry of Health. One of the twelve members of the Council of Ministers is the Minister of Health. The incumbent when I arrived in Tehran was H. E. Dr. Amir Aalam. He resigned for reasons of ill health after about a week, and the post was vacant for the next fortnight. It was filled again by H. E. Dr. Manucher Egbal, who had held that post sometime in the past. The Under-Secretary of Health is H. E. Dr. Abbas Nafici. The Advisor to the Minister of Health is Dr. Bennett F. Avery, who spared no energies in helping the writer to all sources of information concerning malaria and previous malaria control efforts in Iran and in seeing as much of the country as possible.

At present the Ministry of Health is operating a huge medical welfare service. Expenditures during the Iranian year 1325 (March 21, 1946, to March 20, 1947) were 177,984,500 rials ($4,312,000) or 2.9 percent of the total government expenditures for that year. According to the Advisor to the Minister of Health, nearly 95 percent of the total appropriation for the Ministry is used for the maintenance of free medical facilities; only 5 percent is used for preventive medical activities. In and near Tehran, the Ministry of Health operates two tuberculosis sanatoria with about 525 patients and four hospitals with a total of 700 beds. In the provinces it operates two leprosy sanatoria with about 400 patients and 83 small hospitals with a bed capacity of 1,988. In addition, there are some 300 dispensaries run by the Ministry. During the Iranian year 1327 (March 21, 1948, to March 20, 1949) the personnel employed by the Ministry of Health was as given in the table below.

Dr. Avery has labored diligently to reverse the percentages of the treatment and preventive activities, but little progress has been made to date. The prevailing doctrine of fatalism with respect to disease, as with all other circumstances affecting man, and ignorance of the potentialities of preventive medicine makes hospitals and dispensaries appear to be more important than health centers. Thus, the constituents of the Majlis continually demand more hospitals and dispensaries, and an ever increasing share of the resources of the Ministry of Health is devoted to the treatment instead of the prevention of disease.

Seven-Year Plan. A development of the last 2 years may present the opportunity for Dr. Avery to accomplish his objective. Following World War II, Iran found herself in the position of numerous other countries with vast increases in the expenses of government but without corresponding increases in revenue. The poverty of the people

MINISTRY OF HEALTH PERSONNEL, 1948-1949

Types of Personnel	Tehran Area	Provinces
Graduate doctors	193	346
Licensed doctors, dentists, pharmacists, behdars, and midwives	95	357
Pezeshkiars	148	441
Vaccinators	40	400
Others	761	1,740
Total	1,237	3,284

made further taxation out of the question. It was necessary, therefore, to seek means of improving the living standards of the people, to increase exports and to decrease imports. On December 17, 1946, the Iranian Ambassador to the United States executed a contract in behalf of his country with the Morrison-Knudsen International Co., Inc., the latter to survey the potentialities and facilities of the country and to formulate a program for the development and exploitation of the natural resources of Iran, its existing industries, and other fields of production. Concurrently with this study by foreign experts, the government of Iran activated a Supreme Planning Board, under the direction of Dr. Amini, to carry on more extended studies of the social and political economy of the country and to make recommendations for its fiscal improvement.

The report of the Morrison-Knudsen observations and recommendations (date-lined July, 1947) is contained in a quarto volume of 320 pages plus 16 maps. It contains a vast amount of information about existing utilities and resources, together with suggestions for their expansion and development. The cost of the projects catalogued in this report totals about $1,250,000,000, an amount known to be beyond the financial competency of the country. Accordingly, two programs were prepared embodying the highest priority projects which could be accomplished by expenditures of $500,000,000 and $250,000,000, respectively.

The public health section of the report, which is additional to projects for water purification and sewage disposal for the seven largest cities in the country, consists of three parts: (a) the prevention of disease, (b) education of medical and public health personnel, and (c) treatment facilities. The plan involved the construction of 780 health centers, one for each 14,000 inhabitants, a central laboratory and executive headquarters at Tehran, 15 quarantine stations and 10 contagious disease hospitals of 50 beds each, and an educational plant to be used in training personnel to operate public health centers and hospitals. Together with operational expenses, this amounted to some $540,000,000 to be spent within a 7-year period. While the authors of the Morrison-Knudsen report admitted the thorough desirability of such an expenditure, it was obviously impossible to include it within the limits set for their recommendations. Therefore, they eliminated the entire treatment program, 390 of the local health centers, all the quarantine stations and the contagious disease hospitals, half of the construction for the medical education facilities, and 40 percent of the operating expenditures. This reduced the public health allotment to $48,294,000, or 9.6 percent of the $500,000,000 program. In the $250,000,000 program the same public health expenditures were recommended, amounting to 18.6 percent of the total.

On November 10, 1947, Dr. Mosharaf Nafici was invited by the Prime Minister to prepare, with the assistance of the Supreme Planning Board studies and with reference to the report of the Morrison-Knudsen Company, a program for the economic improvement and development of Iran. His recommendations were made available within a month in a mimeographed document entitled "Preliminary Report on the Persian Seven-Year Plan".

The Supreme Planning Board had suggested that the expenditure of some 62 billion rials ($1,937,500,000) would be required over a 7-year period to create a balanced economy for Iran. On the other hand, the financial ability of the country, according to the computations of the Board, could justify the outlay of only one-third of this sum. Dr. Nafici, therefore, based his Seven-Year Plan for the economic development of Iran on the expenditure of 21 billion rials ($656,250,000), of which a fourth or a third would be made in foreign exchange and the rest in rials. He proposed to provide the money by expanding the capitalization of the Bank Melli so that 4.5 billion rials would be available from that source, by devoting to this Plan the total royalties of the Anglo-Iranian Oil Company amounting over the 7-year period to 7.8 billion rials, one more billion from the sale of government property, and another billion from private investment interests. The remainder, 6.7 billion rials, was to be secured as a loan from the International Bank.

Of the 21 billion rials, Dr. Nafici allocated 1.5 ($46,875,000), or 7.2 percent, to public health. In proposing this expenditure Dr. Nafici followed the plan for the "Revised Seven-Year Health Program" submitted by Dr. Avery. This provides a national health institute, 12 quarantine stations, 780 health centers (if three-fifths of the cost of training can be met from special educational funds; if not, only 520 health centers can be built), and special funds for the control of such communicable diseases as smallpox, diphtheria, typhus fever, malaria, trachoma, the venereal diseases, leprosy,

and tuberculosis. Money is also provided for the care of mothers and children, sanitation and water supply, the operation of quarantine stations, and the control of epidemics. Over 208 million rials are allocated for the education of public health personnel, if special educational funds are available for health training; otherwise, 346 million rials will be used for this purpose.

For malaria control, Dr. Avery proposed the following expenditures per year: first year, 2.9 million rials; second year, 11.4 million rials; third year, 18.2 million rials; fourth, fifth, sixth, and seventh years, 18.7 million rials each, a total of 107,300,000 rials. Dr. Avery's report was prepared before the writer had visited Iran and had estimated the cost of malaria control for the country. However, the probable expenditures proposed in this report, for the first 4 years of the program, which may have to be spread over a greater number of years, is of about the same magnitude, viz., 116,000,000 rials. Consideration should be given to the desirability of making adjustments in the proposed Ministry of Health malaria control budget to effect as rapid reduction of malaria as is commensurate with the technical skills which can be made available for this purpose in Iran.

The essence of Dr. Nafici's "Preliminary Report on the Persian Seven-Year Plan" was transmuted into legislative language, and the document was submitted to the Majlis for enactive consideration on May 4, 1948. It was referred to a special Commission, the members of which examined, discussed, and amended the draft. It was sent back finally to the Majlis sometime during September 1948, with a favorable Commission report. According to the New York Times for March 5, 1949, the Majlis has passed the bill and His Highness, Prince Abdor Reza Pahlevi, has disclosed that Iran will make application for a $250,000,000 loan from the International Bank for Reconstruction and Development as a part of this Seven-Year Plan of economic development.

The visit of the writer coincided with that of a representation from Overseas Consultants, Inc. This private concern had been engaged by the government of Iran to review the allocation of funds and to establish priorities for the more important projects to be activated within the Seven-Year Program. The group was headed by Mr. John R. Lotts of Stone and Webster, Inc., and also included Mr. James M. Barker of Sears, Roebuck and Co., Mr. George V. P. Burgess of Coverdal and Colpitts, Mr. Paul B. Coffman, Statistician, and Mr. Walter Skrocki, the Executive Officer of the party. It was possible for the writer to accompany this group on a trip to the Caspian Sea in the north and northwestern areas of Iran. This was a most stimulating and informative experience.

Malaria Findings. The visit of the writer to Iran was too short and during the wrong season to permit malaria survey activities to any great extent. No blood films were made. The spleens of about 25 boys in the Caspian provinces near Babolsar, a few more near Palisht, and others in the town of Jereghan were palpated. About half the school boys in the little town near Babolsar had enlarged spleens, though most of them were small. In the village of or near Palisht where the Near East Foundation had been carrying on sanitary activities there was no evidence of splenic enlargement; in a nearby unsanitated town several of the children had enlarged spleens but none of these were strikingly enlarged. In Jereghan all the children palpated had enlarged spleens and most of these were excessive in size, extending in some instances below the umbilicus. Anopheline mosquitoes were searched for in the Caspian provinces, in and near Abadan, and in Jereghan not far from Shiraz. Only in the last location were any found. These were numerous both in animal shelters and in houses; some were freshly blooded. They were later identified as *Anopheles sacharovi*, and doubtless they originated in the rice fields and swamps near the town in which they were collected.

Accordingly, it was necessary to depend upon information in the literature, routine morbidity reports, and the opinions of others more closely and extensively associated with the problem in obtaining intelligence concerning the prevalence and distribution of malaria and the transmitting species of anophelines in Iran. There are few laboratories in the country where blood films are examined routinely for the presence of malaria parasites; therefore, reported cases of malaria are based primarily on clinical impression, confirmed at times by so-called "therapeutic tests," i.e. uncontrolled therapeutic experience with antimalarial drugs. In recent years from 400,000 to 500,000 cases of malaria have been reported each year. In all probability, many of these cases are not malaria; on the other hand, physicians and health officers probably see or have called to their attention only a small fraction of the actual malaria

sickness. Dr. Avery is of the opinion that no less than 40 percent of the 11,000,000 villagers live under conditions of severe malaria endemicity; he feels that another fifth of this population lives under conditions of mild or intermittent prevalence. The malaria computations have been based on these expressions.

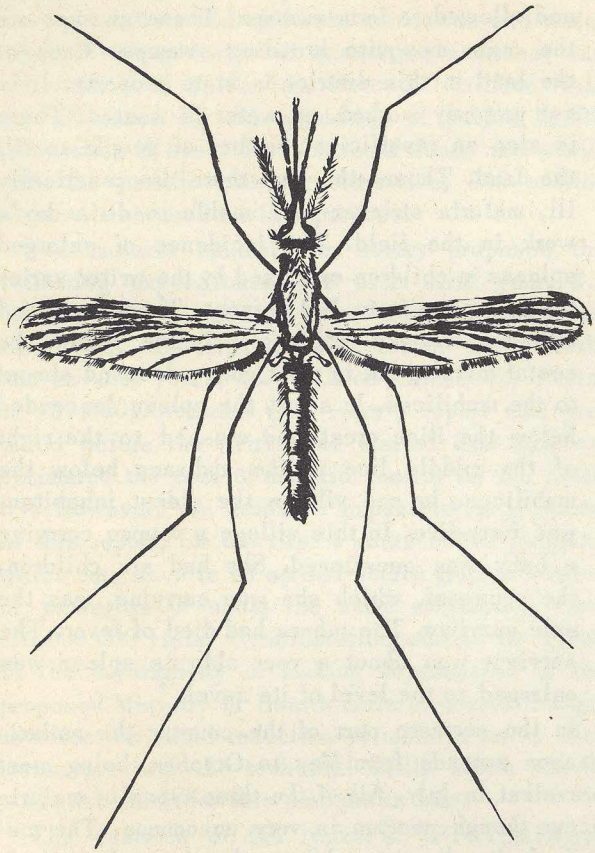
Malaria is reported from all of the ten provinces. It is most important in those bordering the Caspian Sea and in those with irrigated river valleys. Indeed, if one includes metropolitan or highly urbanized sections, the central desert basins, and areas over 6,500 feet above sea level, it may be said that malaria may occur anywhere in Iran that man can live. In the Caspian provinces malaria mosquitoes are produced in natural swamps and in the paddies where rice is raised. Some malaria undoubtedly occurs along the streams in the foothills of the mountains, but especially where these have been partially obstructed to direct water into irrigation channels.

Most of the malaria in Iran is probably associated with irrigation or impoundment. The following quotation from John Gilmour's "Report on an Investigation Into the Sanitary Conditions in Persia," written 25 years ago, is still a very accurate work picture of the most extensive source of malaria in the country.

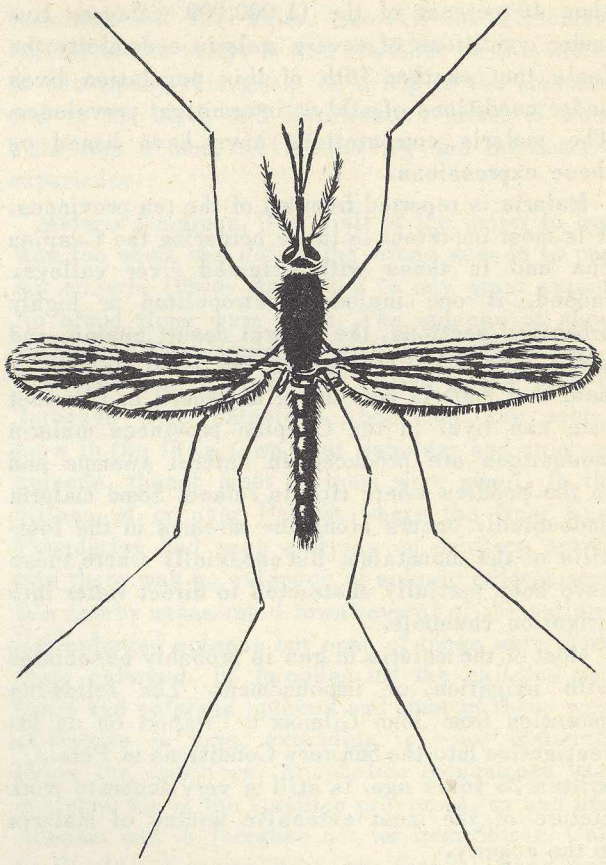
> "The method of irrigating a district must be described and for this purpose the district of Shahriar, to the west of Tehran, may be used as an illustration. The district is part of a fertile plain which lies at the foot of the Elburz range of mountains. It is supplied by water from the river Karaj. Numerous villages are scattered throughout this district. The land surrounding these villages is cultivated by the villagers. The water in the river Karaj is the property of the government. It is sold to the villagers and landowners. Some of these villages are supplied with water throughout the whole year; others have springtime irrigation only. Each village, occasionally two, has its separate water course. These water channels are wide and shallow streams with no proper banks. Much water is lost by leakage and evaporation. Leakage frequently occurs and swamps are formed.
>
> "When the water reaches the village and the district where it supplies the water for irrigation, a hole is cut in the side of the channel, the water is allowed to run into smaller channels and is then led on to the fields. No drainage of surplus water is provided. It is run off the fields and allowed to form swamps. These swamps are the main mosquito breeding swamps. Much of the land in this district is state property. It is not properly worked, as water is wasted. There is also an insufficient number of people to till the land. Those who live there are practically ill, malaria stricken and unable to do a day's work in the field. The incidence of enlarged spleens in children examined by the writer varies from 85 percent to 100 percent. These enlarged spleens are not spleens palpable below the costal margin, but in most cases descend almost to the umbilicus. In some, the spleen descended below the iliac crest and crossed to the right of the middle line of the abdomen below the umbilicus. In one village the oldest inhabitant was forty-five. In this village a woman carrying a baby was questioned. She had six children; the youngest, which 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."

In the northern part of the country the malaria season extends from May to October, being most prevalent in July. All of the three types of malaria occur though quartan is very uncommon. The malaria during August and September is predominantly falciparum malaria. In the southern part of the country the season is somewhat earlier and extends a little later. There may be a low point in incidence during the midsummer while temperatures are so high that mosquitoes do not enter houses.

Iran is the meeting place of anophelines from Mediterranean and Indian regions. A considerable number of species has been reported from the country. It includes *Anopheles superpictus*, *A. sacharovi*, *A. stephensi*, *A. maculipennis* (subspecies?), *A. d'thali*, *A. apoci*, *A. sergenti*, and *A. pulcherrimus*. Doubtless there are others. Of these only the first four are probably of any significance with respect to malaria transmission. Russell, West, and Manwell in their "Practical Malariology" indicate only three vectoral species – *A. sacharovi*, *A. stephensi*, and *A. superpictus*. In London, the writer was permitted to seen an unpublished typescript copy of "The Anopheline Mosquitoes of Iraq and North Persia" by T. T. Macan, a British army officer entomologist who made these observations during World War II. He refers to the three species mentioned above plus an unidentified strain of *A. maculipennis*



Anopheles superpictus



Anopheles sacharovi

which was generally associated with *A. sacharovi* and may be of vectoral significance.

A. superpictus is a vicious transmitter wherever it occurs in Mediterranean area. It must be extensively distributed in the inhabited portions of Iran. It is found in valleys and in hill districts, breeding in the edges of stony streams and irrigation water seepage. The larvae develop in clean, sunlit, sparsely-vegetated water. The adults rest freely in houses and stables, perhaps in outside resting places as well. They are said to hibernate in houses or stables during the winter months. This mosquito is credited with flight ranges up to 4 miles.

A. sacharovi (=*elutus*) is also a Mediterranean species. The larvae are sunshine-loving and are found in fresh or brackish inland or coastal marshes such as rice fields, swamps caused by irrigation, and vegetated rivers. It hibernates in human houses and animal shelters during the winter and rests freely in these places during the rest of the year except in the summer months, when the smallest catches are made. This is responsible for the suspicion that in the summertime some of the mosquitoes rest outdoors, returning inside with the cooler weather. It appears to be less prevalent in southwest Iran than either *A. superpictus* or *A. stephensi*.

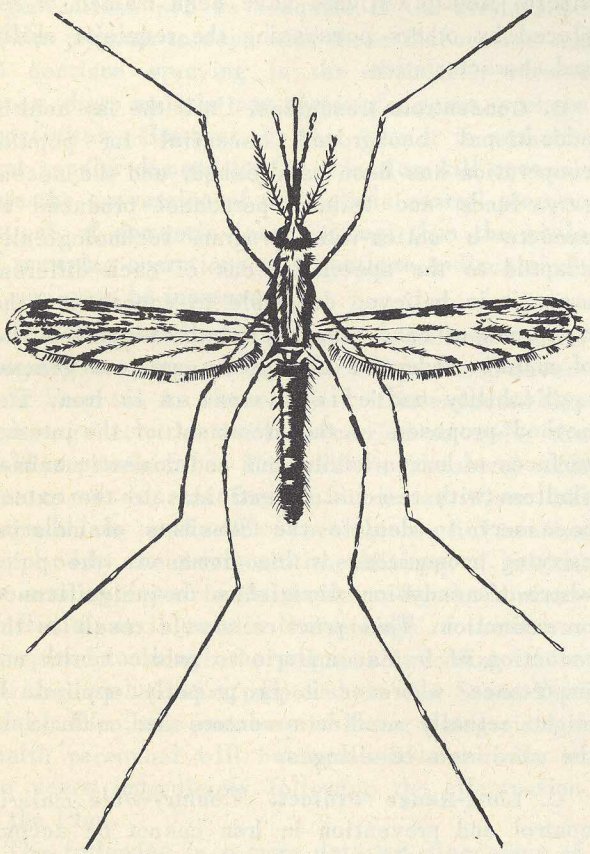
A. stephensi is an Indian species. In Iran it is associated particularly with date palm culture and is found in the southern part of the country. There is no evidence of hibernation; the species probably breeds throughout the year though its prevalence is depressed in cold weather. The larvae are found particularly in small breeding places such as borrow pits, seepage pools, hoofprints, etc. They also may be found in irrigation channels in the absence of tidal movement and of fish, and in the presence of vegetation. In India they are found abundantly in wells and cisterns and other domestic water supplies. It is possible that some of these might also inhabit the ornamental pools which are common on Iranian premises. This species rests in houses behind and on hanging

articles of clothing.

The unidentified strain of *A. maculipennis* (of Macan) is a mosquito which hibernates in houses and stables in the winter months and is found resting in them during the other months of the year. Its breeding habits are much the same as those of *A. sacharovi*; it is frequently associated with *A. sacharovi* or *A. superpictus*. He believes it to be of vectoral significance but does not indicate the basis for this opinion.

As shown above, all of the known three and possibly four species of malaria transmitting anophelines are forms which rest in houses and animal shelters. It follows that the application of DDT to the interior walls and ceilings of these structures would be a logical method of malaria control. This has been shown to be an effective method of mosquito and malaria control with each of the three known species mentioned.

The raising of silkworms in households is a marginal industry in portions of the Caspian provinces. It is unwise to apply DDT in the houses where the silkworms are reared, as this compound is lethal to these insect larvae. Alternative forms of malaria control must be used in such areas.



Anopheles stephensi

Previous Malariometry. In response to an invitation by the Iranian Ministry of Health, the U. S. Naval Research Unit at Cairo, Egypt, made available the services of Lt. Wethersby, a malaria survey and control officer, to appraise malaria attributes in the village near Palisht on the Varamin Plain.

Lt. Wethersby collected blood films from inhabitants and dissected anophelines caught in the area. Only fragmentary bits of information concerning his findings are now available, as the airplane in which he and his wife were returning to Cairo was wrecked and burned. Lt. and Mrs. Wethersby escaped alive, but his notes and slides were destroyed. According to what is known of his findings, the incidence of malaria parasites, both in humans and in mosquitoes from the villages studied, was phenomenally high.

Previous Malaria Control Efforts. The writer is indebted to Dr. Bennett F. Avery for notes concerning antimalaria activities carried on from 1944 to 1948, inclusive.

a. 1944 – Khorramabad

The U. S. Army 111th Malaria Control Unit was carrying on larva control measures around the road camp near Khorramabad. Ministry of Health and Iranian Army personnel were sent for 2-week courses with this Unit and continued the remainder of the season carrying on control in the Khorramabad area under the supervision of Sgt. Carney.

b. 1945 – Khorramabad, Isfahan, Shiraz

Larva control measures were undertaken in these three areas using personnel trained at Khorramabad the previous season. At Isfahan, Dr. Mashaekhi directed extensive control measures using up to 1,500 laborers furnished gratis by landowners. At Shiraz, Army personnel trained at Khorramabad held a training school for other Army personnel and working with the Ministry of Health officials, accomplished considerable control. The landowners voluntarily contributed funds for purchase of 500,000 atabrine tablets for free distribution in their villages.

c. 1946 – Khorramabad, Isfahan, Shiraz, Sanandaj, Kermanshah, and Bushire

Control measures were continued in the first three areas. At Kermanshah the Anglo-Iranian Oil Co. cooperated in larva control over the considerable area near their refinery. At Sanandaj, the

894671 O - 50 - 2

Army garrison contributed soldiers and officers. At Bushire the only breeding area seemed to be the water-storage tanks from which the drinking and washing water of the city was obtained. These were treated with kerosene each week.

d. 1947 – Khorramabad, Isfahan, Shiraz, Sanandaj, Kermanshah, Bushire, Khorramshahr, Ahwaz, Palisht Area and Parchin

Control was continued in the areas listed for 1946. Because of extensive floods in Khuzistan, there was a minor epidemic of malaria near Ahwaz and a large one in the Khorramshahr-Abadan area. Extensive control measures were carried out, primarily by oiling the collections of stagnant water and by treating malaria cases. As the waters receded, breeding also was found in the irrigation ditches of the palm groves so that these had to be oiled.

The Near East Foundation, in cooperation with the Ministry of Health, began some larva control in the Palisht group of villages, but in the main relied on DDT residual spray, numerous villages having the latter treatment. About 26 villages were sprayed, with excellent results.

Parchin was protected by a large-scale larva control project involving the marshes and river bed.

e. 1948 – All Areas of 1947

The Near East Foundation, with some help from the landowners, extended the area of DDT residual spraying with the hope of doubling the area treated. Their reports are not yet available.

MALARIA CONTROL RECOMMENDATIONS TO THE IMPERIAL IRANIAN GOVERNMENT

The following recommendations and comments are made for the development of a national program for the control and prevention of malaria in Iran.

I. IT SHOULD BE DECENTRALIZED, BASED PRIMARILY ON ONE TYPE OF ACTIVITY, AND DEVELOPED IN THREE CONSECUTIVE STAGES OF DEMONSTRATION, OPERATION, AND MAINTENANCE.

A. Decentralize Program. In the opinion of the writer, the malaria control program should be decentralized to the extent that capable health officers are available in the provinces to give the program promotional and technical guidance. Administrative direction and control, coordination, and technologic improvement must come from or through Tehran; the actual selection of areas to be treated, the planning and scheduling of operations, the execution of the work, and the appraisal of its benefits should be accomplished at the provincial level.

Malaria is peculiarly a *local* health problem, involving essentially the mass relationships of bodies of water in which infectible mosquitoes develop and the houses in which people live. The factors of proximity and accessibility between these two relatively fixed entities in and around the 43,000 villages of Iran should be more familiar to resident health officers in the provinces than to individuals whose responsibilities require them to be stationed in Tehran.

Some of the provinces may lack health officers with the perspective, technical background, and executive ability to recognize the need for health improvements and to develop broad programs to prevent disease and disability. In such instances, the Malaria Control Unit in the Ministry of Health must give special assistance until these Provincial Health Officers have been trained or replaced by others possessing the requisite skills and characteristics.

B. Concentrate Resources. Until the lay health-educational background essential for popular cooperation has been established, and the necessary funds and trained personnel produced to execute a nation-wide program technologically adapted to the specific needs of each different area, it is believed desirable to concentrate the resources at hand primarily on the single method of malaria reduction having the greatest general applicability and effectiveness in Iran. The method proposed is the treatment of the interior surfaces of human habitations and domestic animal shelters with residual insecticides to the extent necessary to deplete the densities of malaria-carrying mosquitoes within homes to the point where transmission diminishes to insignificance or extinction. This practice should result in the reduction of Iranian malaria to public health unimportance wherever it is properly applied. It might actually eradicate vectors and malaria in the more isolated villages.

C. Long-Range Project. Country-wide malaria control and prevention in Iran cannot be accomplished overnight or in a single season. There is not enough transport, spraying equipment,

or insecticide on hand to make more than a beginning where conditions are worst. Extension of activities must depend upon popular persuasion by visual proof that spraying residual insecticide within premises will prevent malaria

Accordingly, it is suggested that the first phase in the development of this program be limited to *demonstrational* applications of DDT in areas where malaria is known to be hyperendemic. It is believed that these demonstrations will create a demand for greater coverage. Thus the second phase should be primarily *operational*, energetic efforts being made with expanded house-spraying to reduce to insignificance the malaria morbidity and mortality in areas of perennial prevalence. The third phase should be one of *maintenance*, extending or contracting the scope of operations according to the residual malaria problem. It may be necessary to ascertain the less conspicuous foci of malaria endemicity, to maintain an alert lookout for instances of reintroduced malaria in sections from which the disease has been excluded previously, and to spray each year those areas where infection remains. It is possible that smaller operational organizations will be adequate in the third phase of the program to cope with these discoveries and to continue spraying in the abundantly-watered areas where malaria may persist for years, perhaps indefinitely. However, by that time it is probable that popular demand for fly reduction will necessitate the conversion of the malaria control program to one of domestic insecticiding; thus the scale of spraying operations may continue undiminished; it may even be increased.

The suggested phasing of the malaria control program integrates nicely with the proposed Seven-Year Program. As shown below, it is expected that spraying activities will be carried on under the field supervision of Pezeshkiars (dressers) with Vaccinators as foremen of crews. Over 440 Pezeshkiars and 400 Vaccinators (information supplied by the Advisor to the Ministry of Health) are now employed in the provinces by the Ministry of Health; it is certain that enough of these can be spared to launch the program. According to the training schedule proposed in the Seven-Year Health Plan, the members of these categories of health personnel will be increased materially in the years immediately following the effectuation of the Plan.

The following is a more detailed discussion of the three program stages:

1. *Demonstrational Phase.* This should be carried on for one year mainly at the expense of the National government, working through provincial health organizations, with the cooperation of various voluntary and other agencies interested in public health. More than 50 long tons of 100 percent technical grade DDT and some 400 hand sprayers are on hand in the Ministry of Health. Kerosene is abundantly available throughout the country. These supplies are sufficient to spray about 42,000 houses *twice* during the first season with a 5 percent solution of DDT in kerosene. This is estimated to be nearly 5 percent of the country's total village housing in highly malarious areas and should constitute an excellent demonstration of the effectiveness of oil-borne DDT.

Nearly all of the village housing consists of mud or earthen brick construction, the interior surfaces of which, even when "plastered," appear to be very absorbent. The insecticidal efficiency of oil-borne DDT on such materials has been shown to be variable, doubtless due to differences in the physical and chemical composition of the clays, adobes, daubs, and other earthen surfaces tested. From some parts of the world, efficiencies are reported to compare favorably with those obtained on nonabsorbent substances. However, the more general experience has been that much of the oily menstruum is rapidly absorbed by the dry, porous materials, with the inevitable result that standard application rates (200 milligrams of DDT per square foot, or 2 grams per square meter) do not have normally sustained effectiveness. To compensate for this loss, it is necessary to make applications heavier than standard and thus achieve normal residual effectiveness. This latter resort is wasteful. A further serious disadvantage in the use of oil-borne DDT is its liberal utilization of kerosene (over 21 million liters required for two applications per year in the severely malarious portions of the country). This natural resource fraction can hardly be spared to throw on the walls of Iranian houses while other fuels are in such short supply throughout the land.

Thus the general practice developed with respect to applying DDT on earthen surfaces is to use "water-wettable" DDT, a formulation in which DDT comprises from 50 to 90 percent of the total, with an inert dust diluent such as talc, together with wetting, spreading, and sticking agents. This is applied at standard rates of coverage (2 grams of 100 percent DDT per square meter) and all of

the DDT remains on the surface, available for insecticidal purposes.

It is recommended, therefore, that the demonstrational phase of the program (1949) include a single application of water-wettable DDT to as many houses in areas of high malaria endemicity as are being treated with two applications of oil-borne DDT to compare the residual effectiveness of the two DDT formulations under Iranian conditions. Conclusions should be based primarily on afternoon counts of anophelines found resting in occupied houses. The services of a Malaria Biologist (see Sec. II, A,2 below) would be valuable in making these determinations.

To make such a comparison during 1949, it was suggested before the writer left Tehran that the Ministry of Health purchase 60 long tons of 50 percent* water-wettable DDT and 100 sprayers of the type which can be used for spraying DDT suspensions as well as solutions. This is enough DDT to spray 50,000 houses once with this formulation.

It must be borne in mind that factors other than those mentioned may be found to influence the effectiveness and durability of DDT in Iranian village houses and animal shelters. The practices of cooking indoors without chimneys results in carbon and grease deposits on interior walls, especially of the kitchen. How soon these will tend to occlude and inactivate the surface film of DDT remains to be determined. Heat has a denaturing effect on DDT; conceivably this may be manifest in the hotter portions of the country. The dust which blows in and out of houses may remove some of the DDT by attrition. Thus it is impossible at this point to predict the type formulation or the number of applications of DDT per season best adapted to Iranian conditions. These points should be determined conclusively during the demonstrational phase of the program.

Allocations of DDT, or kerosene, and of sprayers should be made in February or March, 1949, by the Ministry of Health to the provinces on the basis of their estimated relative malariousness. These supplies should be dispatched to the Provincial Health Officers so as to reach their respective destinations not later than March 15th.

Health Officers should be advised at the same time regarding the nature and objectives of the demonstrational program. They should be instructed (1) to store the materials and equipment securely and to hold them until trained spray personnel is available, (2) to choose three pezeshkiars (see Sec. III, B below) to be ready to proceed to Tehran some time in March for training in the technique of DDT application, and (3) to select several demonstration spray areas, both for oil-borne and water-wettable DDT spraying in their own provinces, where malaria is known to be a major cause of premature death, sickness, and physical nonproductiveness. These should be adjacent, if possible, to other areas of high malaria prevalence so that the contrast in malaria experience between the sprayed and unsprayed areas will be marked. They should be easily accessible so that they can be visited by interested landowners.

One of the three trained pezeshkiars should be appointed Malaria Control Officer in each province (see Sec. III, 3 below). Together with the other Tehran trainees, he should teach the technique of DDT application to enough Vaccinators so that they can supervise the application of the DDT allotted to each province. Equipment should be unpacked, tested, and used for training practice; spraying should be under way by the end of April for most of the country. The second application should be made in July following the same order of execution as scheduled for the first treatment. Some modification of this time-table may be necessary on the Persian Gulf littoral and as far north as the summer heat either kills mosquitoes or drives them out of houses. Wherever this bimodal distribution of domestic anopheline densities occurs, the DDT in kerosene should be applied just at the beginning of each house-frequenting cycle.

The size of the spray crews will have to be adjusted to each situation but it will probably be found that three sprayers with a foreman-driver (Vaccinator) is the most efficient unit in villages. Labor for demonstrations should be hired and trained in the village where it is to be employed. If donkeys have to be used, they should be trans-

*It is recommended that 50 percent rather than the relatively cheaper 90 percent water-wettable DDT be used for this experment because experience has shown a greater variability among different lots of the 90 percent product. Some of these have a tendency to lump or coalesce, due to insufficient diluent or mixing especially under conditions of high atmospheric temperatures. Observations should be made with different brands of high concentration water-wettable DDT to determine whether or not any of them will remain consistently usable and effective under local storage conditions. It would be advantageous from a cost standpoint to use such products.

ported by truck as far as roads permit.

A budget proposed for the demonstrational year of the program was estimated at about 8,000,000 rials for operating costs.

2. *Operational Phase.* This will be similar in principle to the demonstrational phase except that efforts should be made to extend DDT spraying to every village in which malaria is a serious health problem. Furthermore, it may be expected that the costs will be divided between government and landowners. Such cooperative arrangements should be promoted and worked out by the provincial malaria control authorities. The foreman should be derived from the Vaccinator component of personnel in the provincial health organizations. They should be instructed in spraying techniques during the winter by the Provincial Malaria Control Officers who directed the demonstrational program in 1949. By this time, it should have been experimentally determined whether or not DDT water suspensions are superior to DDT oil solutions for use in Iran and how many applications of DDT should be made per year. Program logistics and operations should be adjusted accordingly.

Malaria is predominantly a rural disease though it occasionally invades the outskirts of cities. The primary aim of the nation-wide operational phase of the malaria control program should be to reduce as rapidly and extensively as possible, disabling malaria morbidity in village populations located in hyperendemic and endemic areas.

Excluding city dwellers (about 3 million) and nomadic tribesmen (about 2 million) from the estimated 16 million population of Iran, there appears to be some 11 million individuals residing in an estimated 43,000 villages. Some two-fifths of these villages are located, according to the Advisor to the Ministry of Health (Dr. Bennett F. Avery), in areas of intense malaria endemicity, another fifth where malaria is present intermittently but is a less severe health problem, and the remainder in malaria-free terrain. Thus the operational problem is to provide house-spraying service for the 4,400,000 Iranians (880,000 families) living in highly malarious environments.

It is believed practicable to plan to achieve this maximum coverage over a 3-year period. The demonstrational phase, as suggested above, will include the treatment of some 92,000 houses. It is proposed to increase thereafter the number of houses sprayed by almost 300 percent each year. According to such a schedule, the accumulative total of houses sprayed for each of the first 4 years of operation would be as follows:

1949	92,000 houses
1950	350,000 houses
1951	620,000 houses
1952	880,000 houses

On the assumption that each of these families occupies one house or compound, the interior surfaces of which, including domestic animal shelters but excluding floors, average 300 square meters, a budget has been prepared for the annual residual insecticiding of 880,000 houses. This shows the costs of making two applications per year of oil-borne DDT, or single annual treatments with either 50 percent or 90 percent water-wettable DDT. The arbitrary assumptions regarding the number of applications are reflections of the writer's opinion; the type and number of spray treatments best adapted to Iranian conditions remain to be determined by field experiment (Demonstrational phase, above). The budget does not contain the original cost of motor transport (discussed below) necessary to implement completely the nation-wide operational phase of the program, though repair and replacement costs are included. No allowance has been made for local contributions of labor, materials, or funds.

According to these provisional figures, the maximal recurring total and unit costs for insecticiding homes in the more malarious villages of the country would be as follows:

Insecticide Provided	Oil-Borne DDT (Two applications per year)	50% Water-Wettable DDT*	90% Water-Wettable DDT*
	Rials	Rials	Rials
For 880,000 houses	86,064,000	50,600,000	40,128,000
Per 50-house village	4890.0	2875.0	2280.0
Per house	78.8	57.5	45.6
Per person protected	19.7	11.5	9.1

*One application per year

Thus, the per captia costs of DDT application in Iran, if experience proves the validity of the cost data above, would rank among the phenomenally low health investments in the world for malaria control.

If it is determined that one application of 50 percent water-wettable DDT per year is the most effective and durable type of application for Iran, the annual increase in recurring antimalaria expenditures during the first 4 years of the program at the rate suggested above for augmenting house coverage each year, would be approximately as follows:

1949	8,000,000 rials
1950	22,000,000 rials
1951	36,000,000 rials
1952	50,000,000 rials

If either of the other suggested formulations (or such a variation as two applications per year of either type water-wettable DDT) appears superior, annual budgets should be adjusted accordingly.

materials, and equipment - and not as mobile insecticide reservoirs to supply each crew as is customarily provided in some other countries. It seems doubtful if one truck can service more than four crews simultaneously, but it should be possible to determine this ratio more precisely during the demonstrational phase of the program. If experience supports this estimate, 100 trucks will be needed for the 400 crews envisioned. Some of these trucks will not be in service more than from 3 to 6 months of the year for malaria control. Ten pick-up trucks, or jeeps with covered trailers, will be needed by the 10 Provincial Malaria Control Officers, and two passenger cars such as Jeep Station Wagons or equivalent should be sufficient for the Tehran headquarters. The vehicles for the Tehran and provincial headquarters and 30 of the larger trucks should be procured in 1949, 35 more of the larger trucks in 1950, and again in 1951. This would increase the outlays for the first 3 years, proposed above, as follows:

Year	Operational Costs*	Nonrecurring Expenditures	Total
1949	8,000,000 rials	3,474,250 rials	11,474,250 rials
1950	22,000,000 rials	3,185,000 rials	25,185,000 rials
1951	36,000,000 rials	3,185,000 rials	38,185,000 rials
1952	50,000,000 rials		50,000,000 rials

*N.B. Based on the unproved assumption that one application per year of 2 grams per square meter of DDT (50% water-wettable formulation) is the most effective and durable type of domestic treatment.

As stated above, the over-all budget for annual recurring expenses does not include the vehicles necessary to equip the operational phase of the national malaria control program. This is an initial and nonrecurring cost. The same is true of sprayers, but it is believed that enough of the latter are on hand and on order to complete spraying activities proposed for 1949 and 1950. Thereafter, funds should be available from the budget to purchase sprayers for the requirements of the following year.

The number of vehicles required for a spray program where it is expected that labor will be recruited locally is largely a matter of conjecture. It is certain that sturdy trucks will be needed. They will be used mainly to transport foremen,

3. *Maintenance Phase.* It is, of course, impossible at this time to envisage the situation in Iran 4 or more years hence with respect to malaria and its control. Nothing more than a few generalities based on assumptions can be made at present for the guidance of the program after it has reached its peak of operational coverage in the more severely endemic areas of the country. By that time the Ministry of Health will most certainly be faced with the decision of whether or not domestic DDT treatment should be extended to nonmalarious areas. The health and comfort benefits collateral to this type of malaria control program will create strong pressures for its application on virtually a nation-wide basis. Thus the question of maintenance provisions will depend upon whether DDT

is to be used solely as an antimalaria measure in areas where malaria is still a health problem, or for the control of all domestic insects wherever they occur in Iran.

If the program is to be maintained with the principal objective of preventing malaria, some recession in organization and activities should be possible, even though efforts are made to contain progressively the areas of marginal endemicity, estimated by the Advisor to the Ministry of Health to be inhabited by one-fifth of the total village population (operational phase, above). In all probability, much of this malaria prevalence is of the type referred to by malariologists as "secondary" focalizations of the disease. These obtain where transmission, for a variety of reasons, is not self-perpetuating. They exist by virtue of frequently introduced parasites or vectors from "primary" sources, which are self-maintaining. Thus when the principal expanses of primary endemicity are nullified, most of the secondary focalizations usually disappear spontaneously. Nevertheless, an alert watchfulness for inconspicuous but genuine areas of malaria occurrence should be maintained; these should be immediately investigated and controlled if the existence of transmission is verified.

The writer is of the opinion that actual eradication of transmitting mosquitoes or of malaria will be accomplished in numerous localities in Iran if strenuous efforts are made to secure complete and adequate coverage with DDT. So many of the villages are small and isolated that it would seem entirely possible to reduce the vector population to the point, first, of interrupting malaria transmission and, second, of eliminating locally the transmitting species even in areas of primary endemicity. If these surmises are confirmed by experience, reductions may be made in the spray program; but the recognition of these malaria-free areas and their maintenance as such will require careful diagnosis and conscientious case reporting by physicians, and vigilant attentiveness by Provincial Health Officers and Malaria Control Officers. If such malaria-free or vector-free areas develop, every effort should be made to extend their borders, at the same time watching to apprehend and nullify the reintroduction of parasites or vectors.

If the Seven-Year Plan is activated as proposed, numerous new, and additions to old, irrigation projects will be established. These are indispensable for the development of agriculture in the arid sections of Iran. It should always be borne in mind, however, that irrigation systems, improperly constructed and used, may be prolific sources of anopheline mosquitoes. They are probably responsible for much of the malaria in Iran. To prevent the enlargement of the country's malaria problem, the Malaria Control Unit and provincial malaria control authorities should take an active part in advising and educating those concerned in the development and operation of these facilities.

If on the other hand, it is decided to augment the DDT spraying program to protect against malaria *and* much of the enteric disturbance, typhus, sandfly fever, leishmaniasis, and possibly trachoma and topical infections transmitted by flies throughout the country, and to relieve the general population from the nuisance and physical discomfort of mosquitoes, muscoid flies, fleas, lice, etc., a tremendous expansion of the operating organization, its activities, and fiscal support would be necessary. It would require from three to four times as much technical personnel, labor, equipment including vehicles, and insecticidal materials. It is questionable if lasting and satisfactory fly control could be achieved by insecticidal spray methods without fundamental improvements in basic sanitation.

The health and human efficiency objectives of a national or regional domestic insect control program are thoroughly desirable, but they would be excessively expensive to effect in Iran. Whether or not their cost could be justified is a problem for the Iranian government and its people to decide. The situation to be avoided most is the unenviable one of trying to do domestic insect control on a malaria control budget; such an undertaking results invariably in a dismal failure to attain either objective. It commences, whether purposefully or not, when the first house in a nonmalarious area is sprayed with DDT purchased and applied with malaria control money. Such digressions tend to multiply, and each of them impairs the likelihood of achieving the current objectives of the malaria control program. If individuals or communities in malaria-free areas desire to avail themselves of the benefits of residual domestic insecticiding, they should defray its costs. On a small scale, it should be possible for the provincial malaria control organization to render the service on a reimbursable basis; on a large scale, e.g., for a city, special spray crew foremen should be trained by

the Provincial Malaria Control Officer, but the entire expense of foreman supervision, labor, equipment, and materials should be borne locally.

D. Adjunctive Malaria Control Measures. While the writer is of the opinion that more malaria control will be achieved economically in Iran by domestic insecticiding than by any other one technique, there are several additional measures which can be employed advantageously and at little cost. These should be made a part of the general program wherever and whenever circumstances indicate.

1. *Suppressive antimalarial medication.* For example, the rearing of silkworms in households is a supplementary occupation during part of the year in portions of Gilan and Mazendaran Provinces. DDT kills silkworm larvae as readily as adult mosquitoes; under no circumstances should it be applied while living silkworms are on the premises. On the other hand, it seems unlikely that DDT sprayed on ceilings and walls well in advance of silkworm rearing would actually interfere with the development of these larvae. Experimental observations on this point are indicated. But the rearing of silkworms within homes is a capricious undertaking at best, and the persons concerned with it are prone to attribute failures to a wide variety of factors, both real and imaginary. If their houses have been sprayed with DDT, or if it has been applied as a larvicide in the vicinity of the mulberry trees, the leaves of which are used as silkworm food, it constitutes a convenient explanation for the difficulties encountered. It may even be the basis for claims against the persons or agencies applying the DDT.

According to the Seven-Year Plan, it is proposed not only to maintain but to expand present sericultural facilities in northern Iran. Where these activities are carried on, it is probably inadvisable to apply DDT in or near these homes until and unless experimental observations indicate that silkworms may be reared safely in *previously* sprayed houses. Alternative antimalaria measures include larviciding and suppressive medication.

The silkworms are raised on the low, narrow coastal plain extending south from the shore of the Caspian Sea. Much of this area is either naturally swampy or has been flooded for wet rice culture. Irrigation practice is poorly controlled; it would be difficult under the circumstances to develop intermittent irrigation. The surfaces are so extensive that either airplane application or a vast amount of hand spraying would be required to spray oil or Paris green on the paddies and swamps. It is believed that such a practice would be excessively expensive, and would probably be objected to by rice growers, whether or not the larvicide was actually injurious to the young rice plants. It is, therefore, not recommended.

The antimalarial drugs developed during World War II have been utilized successfully under experimental, field, and military conditions for "suppressive" treatment. This means that small doses of these drugs, taken once each week, prevent the appearance of malaria symptoms as long as the medication is continued. They will not permanently prevent or cure all types of the disease. Some weeks after discontinuing the drug, many of the individuals infected before or during the period of medication may manifest symptoms and require therapeutic treatment. The drugs used for this purpose include chloroquine (trade name, "Aralen"), and chlorguanide (trade name, "Paludrine"). The weekly dose of the former is 0.3 gm. of the base, or 0.5 gm. of the diphosphate; of the latter, 0.3 gm. Chloroquine costs two to three times as much as chlorguanide per course of suppressive medication. It is preferred by some malariologists (Coatney in U.S.A.; Clark in Panama) because of its brisker action on vivax malaria, and the longer interval from cessation of treatment to overt malaria. Chlorguanide appears to be more variable in its activity against different strains of falciparum malaria, but is less toxic than chloroquine.

It is believed that the weekly administration of either of these preparations during the months of malaria transmission – April to October – to the villagers where silkworms are raised could be arranged under the supervision of the Provincial Health Officer, utilizing the part-time services of Vaccinators for drug distribution to schools and families. Such a procedure should keep these populations in good health, as far as malaria is concerned, until their harvest season is over. It might then be necessary to supply therapeutic medication to the individuals developing clinical malaria, but if most of the inhabitants of each village take suppressive treatment, it is unlikely that transmission levels will be high, and cases appearing after suppressive medication should be few. The feasibility of spraying houses with DDT after all the silkworms have been reared, thus reducing the period of suppressive medication, should be explored.

The writer has no information concerning the number of persons living in malarious villages where silkworms are raised; therefore, no budget for suppressive medication has been prepared. Unit cost estimates are as follows:

About 30 doses (60 tablets of chloroquine or 90 tablets of chlorguanide for adults; less for children and infants) are required for a complete malaria season. The costs of these medicaments, according to figures made available by the Iranian Ministry of Health, are for chloroquine from 1.0 to 1.3 rials per tablet or 60 to 80 rials per course of suppressive treatment; for chlorguanide, 0.293 rials per tablet or about 26.4 rials per course. To this should be added the costs of distribution, which should be only nominal. Malaria control by suppressive medication should be kept to an absolute minimum. It is an expensive substitute for DDT spraying; it will cost, in all probability, from two to four times as much per person.

2. *Mosquito control in private pools.* Pools which ornament the grounds of Iranian homes and serve as emergency water supplies are numerous, especially in cities. They probably are not preferred anopheline breeding places, though it is quite possible that larvae might be found in some of them on occasion. Most of these are clean-edged reservoirs, though aquatic vegetation flourishes in a moiety. Many are subject to frequent surface agitation by sprinkling (recirculating fountains), or by bailing or brushing water out of them for washing, watering plants, or wetting down dusty driveways. These disturbances of the water deter mosquito production.

The simplest antianopheline measure for these pools is to stock them with insectivorous top-minnows. The most predatory species, *Gambusia affinis,* has been carried literally almost around the world by malaria control authorities, and thus has been used under a great variety of climatic conditions. It is suggested that a *Gambusia* nursery be maintained by each Provincial Malaria Control Officer, according to the excellent directions contained in Chapter 24 of "Practical Malariology" (Russell, Manwell, and West, 1946). Private pools could be stocked readily from these nurseries. Vegetation in these pools should be kept to a minimum for best results in destroying mosquito larvae by top-minnows.

3. *Water management.* Irrigation and flooding are mentioned repeatedly in this report because it is believed that the extended water surfaces involved in these practices are important sources of anopheline breeding and, therefore, of malaria in Iran. These water-holding systems are essential to the country's agricultural development; but if improperly constructed and operated, they may constitute a health hazard nearly as important, economically, as the produce from the soil they moisten. The major impoundments, artificial or natural, which reservoir the water for these systems are probably of less consequence in Iran from a malariogenic standpoint, as they are ordinarily flowing rivers (partially dammed) or natural basins located in the mountains or foothills some distance from village populations.

Irrigation systems have long been associated with mosquito-borne disease wherever the thermal requirements for mosquito development are met. Heavy anopheline production is sometimes encountered in the main channels, especially if water is held there for more than a week. More frequently, however, it occurs in the pools formed when water leaks out of untended dikes, and when the surplus water discharged from the low end of the system is allowed to stand in natural depressions rather than being carried away properly in a drainage ditch. Flooding becomes dangerous when water is held over a week, and when poor leveling tends to spill the water over or through the lower retaining wall.

The prevention of these mosquito-producing situations is educational. The individuals who own, construct, and tend irrigation and flooding facilities should be informed concerning the health responsibilities involved. The structures should be designed and built to hold water tightly, and all leaks should be repaired promptly. Water should not be held anywhere in the system for more than a week. In many parts of the world where rice is cultivated, it has been found that intermittent drying and flooding does not harm the crop and prevents mosquito breeding, or that continuous irrigation with two systems, one dry while the alternate is full of water, achieves the same objectives. There is frequently a tendency, especially when water is not abundantly available, to get more water into the system than the land can absorb. This leads to water-logging of the soil and the discharge of the excess water. Farmers should be taught to control irrigation flows so that their land will be adequately moistened without wastage of water.

The Malaria Control Engineer should be consul-

894671 O - 50 - 3

ted concerning the design of impoundments, irrigation, and flooding systems, so that they can be built to minimize the mosquito production. The Provincial Malaria Control Officers should see that they are operated in accordance with the principles of good water management.

4. *Permanent antilarval improvements.* Such operations as drainage or filling of anopheline breeding places are always welcome environmental improvements to malaria prevention personnel. In view of the type program proposed for Iran, however, it is not believed advisable to promote or finance such expensive undertakings solely on their antimalaria merits except under the most extraordinary circumstances.

On the other hand, when public works are proposed such as piped water-distribution, sewerage, and surface runoff drainage systems which serve other primary purposes in addition to the reduction of casual water surfaces, malaria control personnel should promote and assist actively in their fulfillment.

5. *Diagnostic laboratories.* There are few laboratories in Iran at present in which reliable identifications of malaria parasites can be made. Consequently, most of the malaria diagnoses are arrived at on the basis of clinical judgment. It is not the intent of the writer to imply that typical malaria can not be recognized by its accompanying signs and symptoms; nevertheless, in malarious areas, it is generally true that a strong tendency exists to label all febrile complaints "malaria" unless they are obviously something else.

Good laboratory diagnostic service reduces the number of spurious "malaria" reports and should direct attention to other possible etiologies. Competent microscopists, skilled in thick blood film technique, are essential technicians in such laboratories — but it must be remembered that they are not enough to give the physician the information he requires when parasites cannot be found in thick films. Practitioners rapidly lose their faith in negative malaria reports unless the laboratory is also able to give them some clue as to the nature of their patient's illness if it is not malaria. To that end, bacteriologists, serologists, and virologists should be available to assist in establishing the correct diagnoses of obscure fevers.

It is hoped that ultimately the Ministry of Health will be able to develop diagnostic laboratories of this sort in all the provinces and major cities of Iran. They will do much to define and delineate the actual malaria problem of the country — and to measure progress in its prevention. The basis of the control of malaria — or any other communicable disease — is its accurate diagnosis.

II. THE MINISTRY OF HEALTH SHOULD ACTIVATE WITHIN ITS PROPOSED PREVENTIVE MEDICINE SECTION A MALARIA CONTROL UNIT OF PERSONNEL QUALIFIED TO PLAN AND COORDINATE THE NATIONAL MALARIA CONTROL PROGRAM AND TO GIVE TECHNICAL ASSISTANCE TO PROVINCIAL MALARIA CONTROL AUTHORITIES.

The writer is strongly of the opinion that the interests of malaria control in Iran would be best served by obtaining an experienced malaria control engineer from the U. S. A., or wherever else such an individual could be found, to give operational direction to the program for the several years which would be required before Iranian personnel are really qualified to take it over. In addition to having ample technical and administrative experience, this engineer should be willing and physically able to travel frequently and extensively throughout the country, assisting provincial malaria control operatives in the improvement of their programs.

Individuals with these capacities exist but are hard to find. It is even more difficult to lure them away from their present connections for the requisite period of time. The writer recommends that strenuous efforts be made to locate such a man and that every reasonable incentive be employed to induce him to come to Iran for this purpose. It must be recognized, however, that prospects of achieving this objective in the near future are not great. Therefore, purely from considerations of expediency and of getting a malaria control program under way as soon as possible, the following alternative procedure is suggested.

Pending the establishment of a permanent Malaria Control Unit, it is desirable to activate an interim organization to commence wide-scale malaria control activities in Iran.

A. Interim Malaria Control Unit. It is proposed that this consist of a Malaria Control Engineer and a *Malaria Biologist. Until a medical chief of* the Malaria Control Unit is appointed*, these

*The appointment was expected to be made in June or July 1949.

individuals should be responsible to the Director of the Preventive Medicine Section of the Ministry of Health or, in his absence, to the chief of the next higher echelon in that agency.

1. *Malaria Control Engineer.* The temporary assignment for 3 months to the Iranian Government of a U. S. Public Health Service engineer experienced in directing DDT spraying operations was suggested informally in a letter from the writer, dated November 13, 1948, to the Chief of the Office of International Health Relations, U. S. Public Health Service. On December 13, 1948, an affirmative reply was received through U. S. State Department channels. Thus the Iranian Ministry of Health may now assume that this initial assistance will be made available if an official request is made for the loan of this officer as indicated, and arrangements are executed to guarantee his travel and subsistence expenses while he is absent from his proper station.

He should arrive in February to familiarize himself with the nature and condition of equipment and materials on hand, and the special operational problems likely to be encountered in Iran. By the middle of March, he should commence training the 30 pezeshkiars (see Sec. III, B, below) plus a limited number of nongovernmental trainees in case commercial or voluntary organizations using DDT in Iran wish to send some of their employees to Tehran to take advantage of this opportunity.

Instruction should include the preparation of stock spraying mixtures of DDT (both kerosene solutions and water suspensions), special indications for the use of oil-borne or water-borne DDT; the use of various types of hand-spraying equipment and nozzles; the proper care, maintenance, and repair of sprayers; practice in the application of the correct amounts of spray to different types of surfaces; preparation of houses for spraying; precautions to be taken against causing fires and contaminating food in homes; necessity for spraying behind and under furniture; the marking and recording of sprayed houses, etc. They should be taught also where mosquitoes are most commonly found resting in houses, how to catch mosquitoes for identification, and how to make very simple biological assays of previously sprayed surfaces to determine whether or not they are still lethal to insects. This course will take from 1 to 2 weeks to complete and may have to be repeated; translator assistance will doubtless be necessary.

After the courses are completed, the interim Malaria Control Engineer should spend the remainder of his temporary duty in Iran visiting the provinces, inspecting spray activities, and making constructive criticisms for local improvement in the residual insecticiding program.

2. *Malaria Biologist.* The services of this specialist, while desirable, are not essential to start the demonstration phase of the program. However, he should be available well before the end of the 1949 malaria season so that he can gauge entomologically the relative effectiveness and durability of DDT-in-oil solution and water suspension under Iranian conditions. His observations on these points should be extensive and critical and as well controlled as possible; they probably will become the basis for determining, due consideration being given other circumstances such as cost, whether or not oil- or water-borne DDT is better adapted for use in Iranian villages and how often applications should be made. His most immediate and dominant concern should be the operational improvement of the program in terms of insect destruction. After the most desirable DDT formulation and schedule of treatment have been determined, he should devote himself to a study of the speciation, prevalence, and bionomics of the anopheline forms of Iran, with the objective of obtaining further information concerning the more important vectoral forms, their seasonal and geographic distribution, and their breeding, biting, and resting habits. Biological methods of reducing the malariogenic hazard of irrigation projects should be explored and tested. He should assist the engineer with the investigation of *bona fide* complaints of apparent ineffectiveness of DDT, and the Provincial Health Officers in determining the limits of marginal malariousness.

The International Health Division of the Rockefeller Foundation has been informally queried regarding the possibility of supplying a foreign malaria biologist while an Iranian is being trained, and of supporting the Iranian student during his period of training abroad.

The interim Malaria Control Engineer and Malaria Biologist should be provided with the office personnel and equipment necessary to facilitate and expedite their technical contributions to the program.

B. Permanent Malaria Control Unit. This should consist ultimately of Iranian personnel, including

a Medical Officer in Charge, a Malaria Control Engineer, and a Malaria Biologist.

1. *Medical Officer in Charge.* He should be trained and experienced in malariology, especially malariometry and malaria control, and have administrative, executive, and good public relations abilities. He should assist Provincial Health and Malaria Control Officers, when and where necessary, in plotting relative malariousness and in evaluating control operations in their areas, and should advise them regarding modern regimes for suppressive medication and the radical cure of malaria. He should request from them timely estimates of the amounts of insecticide, spraying equipment, transportation, and antimalarial drugs required for the prosecution of their respective programs. He should actively promote the use of discriminating diagnostic techniques so that the malarial and other febrile infections simulating paludism may be accurately recognized and reported separately. Records of reported malaria morbidity and mortality should be currently analyzed, and unusual, irregular, or suspicious events should be investigated. The Medical Officer in Charge should see that the operational, biological, medical, and epidemiologic phases of the program are coordinated to the best possible advantage. He should take the lead in stimulating a nation-wide program of community health education designed to inform children and adults concerning the cause, transmission, and prevention of malaria.

2. *Malaria Control Engineer.* The basic education of this member of the Malaria Control Unit should be that of a sanitary engineer trained especially in insect control technology. The Malaria Control Engineer should act as the operations and supply officer, giving technical direction concerning all insect-reductive measures for malaria control. He should see that the provincial malaria control personnel thoroughly comprehend their responsibilities and how they are to be discharged. To this end, he should conduct in-service and refresher training courses as needed. He should maintain records of antimalarial materials, equipment, and transport on hand and distributed in the provinces. He should see that stocks are securely stored, that proper records of issue are maintained, and that this material is used only in accordance with the objectives of the malaria control campaign. In anticipation of the future needs of the program, he should verify and consolidate the supply estimates submitted from the provinces, see that these are expeditiously and advantageously procured, and provide for their distribution to provincial headquarters. He should ever strive to reduce the unit costs of insect control operations without impairing their effectiveness. Especial attention should be paid to the operation of old and the construction and maintenance of new irrigation projects, with the object of preventing unnecessary mosquito production. He should visit local projects freely, inspecting their equipment, supplies, and procedures, and make constructive suggestions for their improvement. He should maintain an informative acquaintance with other national malaria control projects so that the Iranian Malaria Control Program can contribute to their advance, and may profit by new developments in other countries.

It is understood that an Iranian civil engineer, now employed by the Ministry of Health, is available. He should work with the U. S. Public Health Service training engineer in 1949, after which he should be sent to the U. S. A. for training in the sanitary science.

3. *Malaria Biologist.* The functions of this individual have been summarized above (Sec. II, A, 2). He will be needed as an integral member of the antimalarial organization as long as it endures.

As far as is known, there is at present no one in Iran with the educational background desirable for specialization in malaria biology, i. e., the parasitology and entomology of malaria. A promising young Iranian should be selected and sent abroad to acquire undergraduate and postgraduate training in these fields. It is not considered advisable in this instance to superimpose this specialized biological training upon a medical education, though there is nothing involved in malaria biology that cannot be readily accomplished by a medical graduate with the requisite training. It is believed that, because Iran is so short of qualified physicians, one schooled in public health biology would be strongly tempted to abandon this latter field to engage in more lucrative medical practice.

If, however, it is going to take too long to accomplish the objectives set forth above, an intelligent young man qualified in the premedical sciences might acquire the necessary practical knowledge by intimate association with an active malaria control project in which residual insecti-

ciding is an integral part of the program, and where a capable entomologist-parasitologist is carrying on investigations. Such enterprises are under way in Italy, Sardinia, Cyprus, Pakistan, India, the U. S. A., Venezuela, Mexico, and doubtless many other countries. The Communicable Disease Center in the U. S. Public Health Service in Atlanta, Ga., U. S. A., has been training foreign students in the field and laboratory aspects of malaria entomology and parasitology for periods of time necessary to meet their individual needs. No formal academic qualifications are stipulated for acceptance, but it is desirable for candidates to have a basic scientific education especially in biology, and be able to speak, understand, read, and write the English language. No academic credits are given for this work.

4. *General considerations.* These three professional individuals should be headquartered in Tehran, but should spend most of their time in the field. Compatible with the policies and regulations of the Ministry of Health, they should be given every opportunity to develop and coordinate the national malaria control program in accordance with generally recognized principles and practices. They should have an adequate travel allowance and be given annual travel orders so that they may leave and return to their headquarters on official business without the necessity of lengthy explanations and time-consuming consideration of their requests before the issuance of leave authorizations for each trip. Travel by air for emergency or time-saving purposes should be permitted. It should be thoroughly understood that a national malaria control program of the magnitude comprehended in these recommendations is a large-scale undertaking, comparable in many respects to a huge business enterprise. Its successful execution will depend in many instances on bold action and quick but sound decisions in the field, without benefit of headquarters counsel. It is, therefore, necessary that it be guided by capable men, who are given a large measure of internal autonomy of direction.

The members of the Malaria Control Unit should be provided with the office personnel and equipment necessary to facilitate and expedite their work. This may be somewhat more extensive than that required for the interim staff. Thus the engineer may require drawing and map-making equipment; the biologist, microscopes, reagents, minor laboratory apparatus; the medical epidemiologist, adding and calculating machines, etc.

A suggested budget for the Malaria Control Unit employees and other personnel concerned with the supervision of the malaria control program during its operational phase amounts to 2,842,000 rials, of which 2,172,000 rials are already provided for in the budget of the Ministry of Health, if one application of DDT is made per year; 4,526,000 rials, of which 3,612,000 are already provided for as above, if it is necessary to make two applications.

III. THE MINISTRY OF HEALTH SHOULD AUTHORIZE AND PROMOTE THE ACTIVATION OF PROVINCIAL MALARIA CONTROL ORGANIZATIONS, AS ELEMENTS IN THE LOCAL PUBLIC HEALTH AND PREVENTIVE MEDICINE SERVICES OF ALL THE PROVINCES.

Basically, this should consist of the Provincial Health Officer and his Malaria Control Officer, enhanced during the spring months by a sufficient number of Vaccinators specially trained to act as foreman for locally recruited spray crews who will apply the DDT throughout the malarious portions of the province. The duties and responsibilities of these various components should be as follows.

A. Provincial Health Officer. He should be administratively and, as far as possible, technically responsible to the Ministry of Health for the malaria control program in his own province. His technical deficiencies will have to be compensated for by the efforts of members of the Malaria Control Unit of the Ministry of Health. In addition to his over-all administrative obligations, he will have certain specific malaria control duties, including malariometry, lay and professional education concerning malaria and its prevention, public relations, and malaria medication where indicated for control purposes.

1. *Malariometry.* The designation of the villages to be sprayed should be made by each Provincial Health Officer, and, with his Malaria Control Officer, he should plan and schedule the program for provinces. Generally speaking, a resident health officer in a district which contains malarious communities, but in which little or no malariometric determinations have been made, is able to place them with reasonable accuracy in one or another of the following categories: (1) malarious, (2) nonmalarious, or (3) uncertain. He may require assistance, therefore, in resolving members of the third group. The quickest method and probably as dependable a method as any, is, by making surveys of

splenic enlargement in children. This should be done by the Provincial Health Officer or a federal health representative. If provincial health laboratories are available, parasite surveys can be made which will produce the necessary information, but less promptly. A third method is to establish the presence of vectoral anophelines in houses. In connection with these last two proceedings, the Malaria Biologist will be useful in demonstrating how to make the necessary determinations. His services should be made available to the Provincial Health Officers to the fullest possible extent to assist them in measuring malaria potentials in marginal areas. All of these malariometric methods should be used also in appraising the effectiveness of malaria control.

2. *Lay Health Education.* The Provincial Health Officer should strive to enlighten the general population in his province about the cause, nature, transmission, control, and prevention of malaria. His efforts are probably best applied as personnel contacts with local government officials, village owners, head men of villages, school teachers, and other key personalities of consequence in malarious communities to be sure that these individuals are correctly informed and that they are motivated to assist in malaria control and in the extension of public understanding about the disease and its suppression. In particular, the Health Officer should see that these facts are presented regularly at the public schools.

3. *Professional Education.* Physicians are taught in medical school how to recognize and treat malaria. It is their legal responsibility to report cases of the disease and to certify it as the cause of death when this appears evident. Nevertheless, busy practitioners in malarious areas fall into the easy habit of calling all febrile complaints malaria unless they are associated with specific signs that obviously suggest some other clinical entity. Deaths preceded by nonspecific fevers are similarly catalogued. This phenomenon is doubtless as prevalent among Iranian physicians as it is among those in other parts of the world. Provincial Health Officers should promote better diagnostic facilities and methods of treatment in the recognition and management of malaria cases. They should encourage conscientious reporting of the malaria morbidity and mortality which comes to their attention, as these attributes assume great importance in the evaluation of malaria control activities. In order to maintain the interest and cooperation of practitioners, the Provincial Health Officer should keep the physicians in his province currently informed about his malaria control plan and activities.

4. *Public Relations.* The advisability of local participation in bearing the costs of communicable disease reduction is a doctrine which has been almost universally recognized in malaria control programs. Owning part of an effective health project gives it value and fosters interest in it; it engenders a sense of responsibility regarding its development and outcome. This principle is advocated for Iran, and its practical implementation should be worked out between the federal and provincial malaria control authorities. The pattern of effective collaboration between government and communities of landowners will have to evolve in response to its own environmental influences. What will finally be considered a just, equitable, and productive arrangement remains to be seen. Mutual participation may stabilize, for example, at the point where only labor or perhaps labor and materials are supplied by landowners, with government providing equipment, transport, and technical superivsion; or government may ultimately contribute nothing more than technical direction. Whatever the final arrangements, their promotion and execution from a public relations standpoint should become prime responsibilities of the Provincial Health Officers.

5. *Malaria medication.* The treatment of malaria cases should be left as far as possible to private practitioners and medical welfare services. Under conditions of high transmission potentials, it rarely has measurable preventive values. However, there are areas of Iran, where silkworms are reared in homes, in which the temporary suppression of malaria symptoms by medication to maintain the physical effectiveness of inhabitants during the agricultural season may be indicated as a more feasible undertaking than malaria prevention by environmental means. The supervision of such suppressive medication projects should be a responsibility of the Provincial Health Officer.

B. Provincial Malaria Control Officer. It is proposed that the Malaria Control Officers be selected from the ranks of "pezeshkiars" (dressers) in each province. These individuals are already employees of the Ministry of Health. They have had several

years at public school, can read and write, are acquainted with the geography and inhabitants of the province in which they are employed, and are already popularly identified with health activities.

In order to make the initial appointment of Malaria Control Officers, it is suggested that the health officers of each province be instructed to select three trustworthy, intelligent, young pezeshkiars able to direct labor, drive trucks, and assume responsibility.

These selectees should proceed to Tehran at government expense sometime when called (probably in March) for training in the technique of DDT application (Malaria Control Engineer, above).

At the end of the training period, the pezeshkiars should be issued their operational transport, if this has not already been sent to the provinces, and they should return to their respective headquarters. The best of the three trainees from each province should be appointed Malaria Control Officer by the Provincial Health Officer on the basis of his own knowledge of the men plus consideration of their grade marks assigned by the interim Malaria Control Engineer; the two other trainees will become assistants to the Malaria Control Officer, his replacement if necessary, or spray crew foremen.

The Malaria Control Officer will be responsible to his Provincial Health Officer for the operation of the nonmedical phases of the malaria control program in his province. His duties will include training of Spray Crew Foremen (Vaccinators) and their operational direction thereafter. He should maintain records of antimalarial materials, equipment, and transport on hand and distributed throughout the province. He should see that this material is used only in accordance with the objectives of the malaria control program. He should plan and schedule the activities and know the day-to-day location of the various spray crew foremen and their crews. He should visit local projects freely, inspecting equipment, supplies, and procedures, and make constructive suggestions for their improvement.

C. Spray Crew Foremen. These should be drawn as needed from the ranks of Vaccinators; they will be required only for from 2 to 4 months per year. This group of Ministry of Health employees is not as highly educated as the pezeshkiars, but is able to read and write. Its members are generally familiar with village locations and inhabitants in the provinces where they are employed. They also are popularly identified with health activities.

Spray Crew Foremen will be responsible to the Provincial Malaria Control Officer. Their duties will be to recruit, locally, labor crews of three men each, and to train them to mix and apply DDT. They will supervise these men during operations. The Foremen will be responsible for the transport, equipment, and materials issued to them during their employment.

D. Spray Crews. Ordinarily the members of these crews will be recruited from the inhabitants of the village in which they are to spray, though in some instances it may be economical or expeditious to use them in nearby villages as well. They will be responsible to the Spray Crew Foreman while employed. Their job will be to mix and apply DDT to the interior surfaces of houses and animal shelters.

IV. IT IS RECOMMENDED THAT THE MINISTRY OF HEALTH ENCOURAGE AND ACCEPT ASSISTANCE IN MALARIA CONTROL FROM OFFICIAL AND VOLUNTARY AGENCIES AND ORGANIZATIONS COORDINATING AND UTILIZING THE VARIOUS FACILITIES MADE AVAILABLE TO IMPROVE AND EXPEDITE THE NATIONAL MALARIA CONTROL PROGRAM OF IRAN.

Certain official and voluntary agencies have indicated interest in the proposal to make a systematic and strenuous attack upon malaria in Iran. Some of them have helped already in the planning stage of the campaign; others have expressed a desire to assist in the future.

Malaria in Iran is such an extensive and serious health problem that it constitutes a substantial hindrance to the economic evolution of the nation. It is a heavy and unnecessary tax laid on the productivity of its people. Its amelioration would go a long way towards the establishment of self-sufficiency in agricultural achievement, and the development of exportable surpluses. Done in the name of the government, it should have values in generating confidence in the government.

The problem of malaria abatement is not an insuperable one. The brief study which is the basis of this report has convinced the writer that paludism can be drastically reduced – probably eliminated in numerous localities – at a price well within the means of the country.

But it takes something more than money to control malaria. It requires technically trained and experienced supervisors, placed in positions of authority and consistently supported, financially

and morally, by the government to operate a nation-wide program of malaria control according to accepted principles and practices. Such persons are not now available in Iran. They must be developed for such responsibilities by training abroad and experience at home under the guidance of competent authorities.

The will to accomplish this task must become an attitude not only of government but of the people, rich and poor. This can be effected only by an enlightened understanding of the nature of malaria and the ease with which it can be prevented. That comprehension may be brought about by disseminating information and education regarding these subjects. The teachers and materials with which to accomplish such an undertaking are still to be developed in Iran. The techniques of health education must be acquired by training in foreign countries. The equipment necessary for placing this information in intelligible form before masses of illiterate villagers must be imported. Much of the material to be presented must be created, or adapted to Iranian understanding.

The agencies interested in Iranian malaria control can help in supplying some of these deficiencies if mutually satisfactory arrangements can be worked out. The more important of these agencies are listed below, together with suggestions by the writer for what he conceives to be the best utilization of their interest and facilities. If, in the opinion of responsible officials in the Iranian Government, these appear to be consistent with the best interests of nation-wide malaria control, it is recommended that these officials lose no time in taking the steps necessary to invite the participation of these agencies. In accepting this assistance, it should, of course, be thoroughly understood by both parties that the Iranian Government is in no wise yielding its statutory responsibilities for malaria control and related activities.

A. The United States Government has already manifested its interest in the proposed Persian malaria control program by making available the services of planning and training officers from the Public Health Service to assist in the initial phases of program development. Whether or not the United States Government has plans or would give favorable consideration to plans for further participation in this project is beyond the knowledge or province of the writer.

B. The World Health Organization is assisting certain countries to initiate malaria control by providing technical supervision and some of the supplies necessary for demonstrations of these activities. Inasmuch as the WHO budget for these projects is relatively limited, and the number of member states which might invite such assistance is so large that all requests cannot be filled simultaneously, it is not known how soon such aid could be made available or how extensive it might be. Certainly the initiation of malaria control activities should not be held in abeyance pending the fulfillment of an official request for WHO assistance.

C. The International Health Division of the Rockefeller Foundation has signified in various ways its sympathetic interest in public health development in Iran and in malaria prevention in particular. Headquarters and regional representatives have visited the country; a Foundation office is being established in Tehran; Dr. Paul F. Russell, a staff member and an eminently distinguished and able malariologist, is planning to spend some time in the country this spring; and agents of the Iranian Government and the writer have been assured of the desire of the Foundation to be of assistance in the proposed malaria control program for Persia.

As indicated above in Sec. II, A,2, the International Health Division has been informally queried on the subject of supplying an interim Malaria Biologist for this project, and of providing for the training in this specialty of an Iranian replacement on the permanent Malaria Control Unit. The response to this inquiry will doubtless be forthcoming after Dr. Russell's recommendations have been made to the home office.

Further suggestions for Rockefeller Foundation participation, both directly and indirectly, are as follows.

1. *Malaria Control Operations Officer.* The writer is impressed, as indicated above in Sec. II, B, with the desirability of placing this program under the technical and administrative supervision of an experienced malaria-control operations expert for the 2 to 4 years which would tide it over its most critical developmental period. This would permit Iranian personnel to gain professional experience and stature in the eyes of their fellow citizens before taking over the direction of this project. The Rockefeller Foundation has a considerable cadre of personnel of unparalleled qualifications for just such a responsibility. If the

Foundation could be prevailed upon to loan one of these individuals to Iran with the understanding that the Iranian Government would staff and support his activities adequately, it would constitute not only a splendid token of cooperation on the part of the Foundation but as near a guarantee of the success of the program as could be made at that time. In the event that an operational chief could be supplied by the Foundation, it is suggested that he be placed in administrative charge of the Malaria Control Unit.

2. *Public Health Fellowships.* In conformity with past policy and practice, the Rockefeller Foundation plans, presumably, to continue sending candidates from Iran and other countries to foreign schools for public health training. The presence of trained Health Officers in all the Provinces of Iran (only a very few are thus staffed at present) would be the second major contribution of this organization towards the success of the malaria control effort, and of improving health administration in general throughout the country.

3. *Diagnostic Laboratories.* The third way in which the Rockefeller Foundation might benefit both malaria prevention and the control of other communicable diseases would be by assisting in the development of laboratory medicine in Iran. Until skilled technical personnel and facilities become available for the accurate diagnosis of these diseases which cannot be recognized with certainty by clinical observation alone, it will remain difficult for advances to be made either in therapeutic or preventive medicine. Supervisory and satellite technicians in the fields of bacteriology, virology, parasitology, and serology are critically needed.

The prime location in which these services would be most productive would be at the five existing medical schools; the second would be in the health centers in the other major cities. If the students attending Iranian medical schools could see and participate in the activities of high quality diagnostic laboratories, and then, after graduation, have comparable facilities available in the principal municipalities of the nation, the effectiveness of Iranian medical service would be greatly improved.

D. The Concern of the Iran Foundation for improvements in malaria control has been substantially indicated by its defraying the expenses incident to travel of the two Public Health Service officers from the United States to and from Iran on malaria missions. It is recommended that the future participation of this organization in the active malaria control program might be along the two following lines:

1. *Malaria Control Assistance in Fars Province.* The civic regard of the founder of this agency for his native city of Shiraz and Fars Province, inspires the suggestion that the Iran Foundation might well cooperate financially with the Provincial Health Officer in a malaria eradication project to include the city, which is not highly malarious, and its surrounding villages, in some of which malaria is severely hyperendemic. If such a project were successful, and it seems entirely feasible, Shiraz would probably become the first major malaria-free city in Iran and the focus of an ever-expanding malaria-free area of the country. Such an example might motivate similar undertakings in other sections of Iran.

2. *Health Education.* The first sentence in the Articles of Incorporation of the Iran Foundation announces that its prime objectives are the improvement of standards of health and education in Iran. It appears to the writer that an unexcelled opportunity to make progress towards these two worthy goals exists in assisting the malaria control program throughout the nation by providing the health education facilities necessary to enlighten the unschooled rural population concerning malaria, so that a sympathetic and cooperative attitude towards control activities will be assured. Iranian health educators should be trained, Iranian health educational materials – printed, pictorial, audio-visual, even radio – should be prepared, and a nation-wide effort should be made in cooperation with existing health and educational agencies to bring to the children and adults of Iran the basic facts about the cause, nature, transmission, treatment, control, and prevention of malaria.

Such a very specific undertaking might serve as a pilot project to assemble the organization and equipment, establish the contacts, and develop the necessary techniques and operations for health education programs of a broader character. These are essential supplements to the professional and technical development of local health services – yet they are frequently the most neglected!

E. The Near East Foundation is dedicated to increasing the welfare of rural populations in Levantine countries by effecting educational, voca-

tional, and health improvements in the lives of these people.

The sanitary engineer member, Mr. Theodore Noe of the Tehran office, has been outstanding in developing and introducing novel methods of rural sanitation in the villages where the Foundation carries on its activities. A group of these is located on the Varamin Plain some 20 miles southeast of Tehran. Mr. Noe has probably used more DDT for residual insecticiding than anyone else in the country to date. Arrangements were completed several months ago for him to supervise DDT applications in the southeastern (Iranshahr) section of the country.

It is recommended that the Near East Foundation participate in the malaria control program in the future as it has in the past, i.e., by assisting Provincial Health Officers in carrying out malaria control activities in areas where the Foundation has special interests. It is also probable that Mr. Noe could be of service to the national program in suggesting technologic improvements in operations based on his experience.

F. The Anglo-Iranian Oil Company has provided very adequate local health facilities, including malaria control, for its employees, both in the various fields from which oil is pumped, and in and around Abadan where its principal refinery is located. It is presumed that the Company will continue to supply these services wherever it has active operations.

V. IT IS RECOMMENDED THAT CONSIDERATION BE GIVEN TO THE INTRODUCTION TO THE MAJLIS OF LEGISLATION (A) EXEMPTING FROM IMPORT CHARGES ANTIMALARIAL SUPPLIES DISTRIBUTED FOR PUBLIC BENEFIT WITHOUT PROFIT, OR (B) REMITTING TO IMPORTERS THE CUSTOMS DUTIES COLLECTED ON SUCH SUPPLIES.

It was observed during this study that it is the practice to charge importation duty on DDT, sprayers, antimalarial drugs, etc. which have been brought into the country by the government to be used or distributed for the public good without charge. This varied roughly from 15 to 30 percent *ad valorem*.

Doubtless there was originally some excellent basis for customs legislation so inclusive that it permitted no exemptions. In the instances mentioned, however, it appears that the government is depleting one of its own appropriations to increase government income. Whether or not this affects the size of the effective funds appropriated to the Ministry of Health is not known. If it does, it would appear that this Ministry is being penalized for importing goods which can not be produced in the country; if not, it is apparent that much unnecessary bookkeeping is necessitated by this practice.

It is suggested that some member of the Majlis might be interested in framing and presenting legislation which would accomplish either of the objectives embodied in the recommendation above. It is possible that if the principle involved is considered sound, that the law should be written to make the practice broader by including health or medical supplies, in addition to antimalarial equipment and material. It is certainly desirable that material intended for the prevention of or relief from disease, and which is going to be used for the public good without profit, should enter the country as cheaply as possible.

VI. IT IS RECOMMENDED THAT THE POSSIBILITY OF CONVERTING TECHNICAL GRADE 100 PERCENT DDT TO WATER-WETTABLE DDT IN IRAN BE INVESTIGATED.

Prior to coming to Iran, the writer explored the feasibility of manufacturing DDT in that country. It was learned that sulphuric acid, benzene, chlorine, and ethyl alcohol are the raw products from which this insecticide is made.

In discussing manufacturing possibilities in Abadan with the General Refineries Manager, Mr. J. Rigden, it appeared that of the four products, only the first was presently available in large quantities. It was concluded in this conversation that the production of DDT would be much more expensive than its importation.

DDT may be imported as 100 percent technical grade and as 50 to 90 percent water-wettable. The latter contains from 10 to 50 percent of an inert diluent such as talc, pyrophyllite, etc. Obviously it is wasteful to pay costs and freight for an inactive agent. If a suitable clay exists in Iran and can be obtained cheaply, it might be worth while to consider the possibility of importing only 100 percent technical grade DDT, and of pulverizing and mixing the DDT and clay, together with the adjuvant sticking and wetting agents. Machinery for the processing of dusts per day is said to cost about $5000.

A summary of specifications for diluent dusts for use with DDT has been sent to the Adviser to the Ministry of Health.