EXPERT COMMITTEE ON MALARIA

REPORT ON DR. PAMPANA'S MISSION TO GREECE AND ITALY

Within a few hours of flying across the Central Mediterranean basin, one may watch three distinct programmes of antimalaria campaigns carried out by means of DDT. In Greece there is a nation-wide scheme based on anti-imago as well as on anti-larval measures, the latter carried out by hand and by air-landing spraying; in Peninsular Italy the campaign is limited to house-spraying and in Sardinia an impressive campaign is being carried out by anti-imago and anti-larval methods aiming at the complete eradication of anophelines in the whole island.

All these campaigns, however different, have some features in common: they are based upon DDT and they are worked under the auspices of the Public Health Administrations of the countries concerned, with the technical collaboration of the WHO.IC (Greece) or of the Rockefeller Foundation (Sardinia and Greece) and they were all started thanks to the enormous help and (except in Sardinia) also to the technical guidance given by UNRRA.

It is certainly striking, in the long history of malaria, to realize the speed with which DDT has been put into application and has superseded practically all other means of malaria control. When oiling or Paris greening were first introduced, experiments were undertaken in most countries with a view to finding out the merits of these new methods and the best way of applying them in particular circumstances; local programmes were developed on a trial-and-demonstration basis and they produced a great amount of data upon which eventually larger programmes were planned and carried out. In the case of DDT, on the contrary, although very valuable and careful experimentation was carried out in some places, very little of it was done in European countries in which the malaria problem had always been serious and had become more so on account of the war. Probably no other instance is known of Governments having devoted enormous sums of money to the application of a new public health measure on the basis of experience gained in
foreign countries or of very brief and restricted local trials. DDT, and especially its residual toxicity, loomed as an all-powerful weapon in fighting malaria; and in countries where so many problems were jeopardizing the future and the life of the people, it seemed humane that at least one of the greater problems should be tackled with the utmost energy, once it was known that DDT could promise its solution.

It is probably a consequence of this eagerness that the methods of application of DDT in two countries like Greece and Italy, separated by only a few hundred miles of sea, should differ so widely. The programme of the former is more complete and expensive than that of the latter, but we do not yet know whether the more thorough and costlier one is going to give better results than the other; both will really have to be considered as experiments and their relative value cannot yet be appraised.

In Italy and Greece, after the first field trials of 1944–1945, DDT was applied in 1946 and is applied in 1947 on a national or nearly national scale. In Greece it was thought that the destruction of hibernating anopheles should make the opening stage of the campaign, and that an anti-larval campaign should supplement house-spraying, while in Italy (with the exception of Sardinia which stands by itself) it was thought sufficient to spray houses and stables once a year, shortly before the malaria season. The technique of house-spraying itself was and is different, for in Greece, all the structures are sprayed from floor to ceiling at the rate of about 2 grammes of DDT per sq. metre, while in Italy a discreet choice is made of the buildings to be treated, the lower part of the walls (as well as the high ceilings, in Sardinia or in the province of Frosinone) are not sprayed and the amount of DDT per unit of surface is lower. Moreover, since the lower 5 ft. of walls are disregarded, there is no need to remove the furniture placed against the walls, with consequent saving of labour.

Clearly, if the latter policy gives good results, then the former is unnecessarily expensive.

Both in Greece and in Italy, the 1946 campaign has had very good results in reducing malaria morbidity; but it is difficult exactly to assess the benefits of the campaign, as has been said in the sections concerning the various programmes; for in Greece the endemic-epidemic character of malaria epidemiology gives a great variability to endemic indices from year to year, while in peninsular Italy the campaign was initiated following a proper epidemic of malaria and we know that this is the worst period for any quantitative appraisal of anti-malarial measures. One may
regret that comparison areas were rather few, although these few, as well as many other considerations, point clearly to the efficacy of the campaign. The best experiment would probably consist in testing the results of a residual toxicity campaign in regions of hyperendemic malaria such as we have in the tropics where, transmission being constant, the spleen index is constantly on the same level year after year. Now in Sardinia there are areas of this type where the spleen and parasite rates of the child population should be available over quite a number of years. As in most of these areas no anti-larval campaign will be carried out in 1947, therefore any significant lowering of the rates in March 1948 will constitute a convincing quantitative proof of the value of the anti-imago operations.

Anti-larval campaigns.

Anti-larval operations with DDT are much cheaper than with Paris green and particularly with oil.

According to the field research done by Dr. AITKEN in Sardinia, 5 mgm DDT per sq.m. being enough for an eradication scheme, the material (DDT, diesel oil and Triton X-100) for the treatment of an hectare would cost at present prices approximately 161 lire, i.e. one-twentieth to one-fiftieth of the cost of employing oil alone. The reduction of DDT from the usual dose of 10 mgm to 5 mgm per sq.m. not only allows of a very large margin of safety for the survival of aquatic fauna, but also represents a great saving, for in the prices quoted above, the cost of DDT nearly equals the cost of the oil.

But even if larval control with DDT is much cheaper than previous methods, it still remains an expensive proposition. In Sardinia where the anti-larval campaign appears unavoidable, considering that the aim is eradication of anophelines, DDT spraying of actual or potential breeding places is repeated weekly for 26 weeks. In Greece, where the purpose is not so radical, it is repeated at longer intervals; but the interesting point is that the Greek experiment, compared with the Italian one, might be able to tell us whether it is necessary, or at least worth while, to associate anti-larval measures, with an anti-imago campaign (incidentally this is one of the reasons that makes one deplore that the house-spraying technique is not exactly the same in both countries, so that a fair comparison could be made).

Theoretical considerations upon the "rationale" of an anti-larval campaign as an adjunct to DDT residual spraying show how ill-informed we still are about the
bionomics not only of anophelines in general, but of vector species as well.

Supporters of larval control will say that this line of attack appears necessary wherever people have the habit of sleeping outdoors; opponents will say that they may be bitten by anophelines, but insomuch as these will always rest indoors, they will be killed by DDT before they are ready to transmit the infection.

This argument presupposes that all the females of a given species have the habit of resting indoors, on the basis of our usually finding indoors some individuals of the species. Now, without taking into consideration species other than Mediterranean anophelines we cannot forget that females of these species (A. imbrichiæ, A. clutus, A. superpictus) have also been found to rest outdoors (SAUTET, Van THIEL, MARNEFFE), although we do not know whether this exophilism is a temporary or a permanent characteristic of some individuals, nor whether it becomes widespread in certain climatic circumstances. It would, however, seem logical to presume that mosquitoes even of vector species breeding in places farther from human habitations than their flight range, might be always exophilic; and if during the summer people happen to spend their nights in the fields near the breeding places of these mosquitoes, transmission should be possible. However, such an event requires the concurrence of so many circumstances that we could perhaps discard it. A possibility that a priori we cannot discard is that among the population of a house-haunting species there might be a proportion of individuals, at least in particular climatic conditions, which are not house-haunting, but prefer natural shelters (1); if so, people sleeping outdoors, even in the vicinity of the houses, might contract malaria.

(1) The habit of studying the anophelines by making occasional or periodic daytime captures of them in houses or stables is very empirical. In July and August the curve of anopheline density in Italy drops to an extremely low level. Does it correspond to a real reduction of the imago-population or to a preference for cooler shelters? or is it simply an erroneous generalization, the mosquitoes coming indoors late at night and flying out again at dawn? Captures are usually not carried out during these nightly hours except in countries where the mosquitoes are never found indoors in the daytime.
This summer has been so hot that no doubt even in penin-
sular Italy, where no larval measures are undertaken, lots
of people will have been spending parts of the nights out-
doors. Besides, in some small centres where DDT house-spray-
ing is done, open-air cinemas operate in the summer. Accu-
rate investigation of the history of
all primary cases of malaria that might occur during the
summer in such localities will probably help us to ascertain
whether anti-larval measures are necessary to protect people
outdoors at night, in the vicinity of houses which are pro-
perly sprayed.

Anti-imago campaigns

As in countries like Greece and Italy residual DDT spray-
ing succeeds in interrupting transmission, one would like to
know whether the anti-imago campaign should be repeated
every year, forever, or whether it would be possible to
discontinue it after a number of years.

One can reason as follows:

a) progressive reduction of transmission will result in
the disappearance of gametocyte carriers among the
population; and

b) repeated anti-imago campaigns might bring about
enormous reduction of the vector density so that
even if new gametocyte carriers were introduced in
the area, transmission might be represented only by
scoradic cases of malaria.

But, short of complete eradication of the mosquito
vector species from the area and the prevention of its
reimportation, discontinuing the anti-imago campaign
would allow the remaining population of mosquitoes,
reduced as it might be, to breed again unhampered; and
as it is very difficult to prevent gametocyte carriers
from being introduced again, transmission ought to
start anew.

Therefore, it seems a priori that repeating house-spray-
ing even for several years cannot guarantee our being able
to give it up later. Hence the necessity of trying to adapt

(1) House spraying could even be considered as a kind of
species sanitation for it kills especially mosquitoes
having contact mainly with man: MISSIRILO has observed
that after house-spraying a remarkable decrease occurs
in the larval density of A. maculipennis lebranchiae,
not of A. claviger, or of the zoophilic varieties of
A. maculipennis.
the campaign to the budgetary possibilities of the malarious countries.

Some differences in the cost of the Greek programme compared with that of the Frosinone or Latina ones have already been pointed out, the Greek programme appearing to be more expensive. On the other hand, the Greek house-spraying technique is cheaper for it employs DDT in the form of watery emulsion and not, as is done in peninsular Italy, in the form of a kerosene solution. (1) Besides being cheap, the use of emulsion saves much in transport (for the 26% concentrate and not the 5% emulsion will be transported); it does not require additional expenses for preparation, as does the solution, and lends itself less readily to pilfering. Also it may be conceived that emulsion would become even cheaper if the concentrate itself were prepared at the headquarters of the DDT campaign instead of being shipped in barrels from the United States. A much more substantial saving will be achieved if the DDT miscible powders could be universally applied. Even if the cost of the wetting agent contained in these powders equalled the cost of the solvent and the emulsifying agent present in the concentrate, the transportation of the product would represent an enormous saving (instead of large trucks transporting barrels full of concentrate, a jeep would be sufficient) and while at work, the sprayers would not lose so much time in going back to their filling point for they could easily carry enough powder for all the refills needed during a day's work. Furthermore the use of watery suspensions of DDT would eliminate the danger of dermatitis, for it seems that skin lesions of the sprayers are caused by the solvents and not by the DDT itself.

But even if a form of applying DDT much cheaper than those now in general use can be found eventually, it it seems hardly likely that governments of malarious countries which usually happen to be also poor countries, at least as far as Europe is concerned, would be capable of devoting

(1) In Greece the difference in price between the emulsion and the kerosene solution is not very high (about 13%), but in Italy, according to prices quoted by Dr. PATRISSI, of the Malaria Division of the High Commissariat for Hygiene and Public Health, one kg. of kerosene would cost 65 lire and the 5 gr. of DDT 60 lire, i.e. 125 lire, while one kg of the final 5% water emulsion (made out of the 26% concentrate which costs $ 60.00 per metric ton) would come to 27 lire (at the official rate of exchange of 225 lire to one dollar).

(2) In the Latina organization, for instance, out of a total spraying force of 56 men, two men were employed full time for making the solution, that is approximately 4% of the total labour available.
year after year, such considerable sums to a nation-wide anti-malaria campaign. Obviously, expenditure on malaria control should be decentralized. But how would provincial or regional authorities today, still suffering from the aftermath of the war, be able to meet the expenses for a DDT programme? As a matter of fact, it is to be hoped that the whole programme can be paid for by the population itself; Greece and Italy have each offered half the solution of the problem and by combining the two suggestions the entire problem could be solved.

We must not forget that there has never been a public health measure that has "sold" so well to the public as DDT house-spraying. Its popularity can be made use of. Once the population has enjoyed the benefits of DDT, it will even be prepared to pay for it, if need be. Now in Greece, the communities offer food and lodging to the men of the spraying teams, and in Crete the communities go farther than that and pay their salaries. This, as we were saying, solves part of the problem, the cost of labour, but not that of the equipment and material nor the salaries of those in charge of the technical supervision. This might be paid by the landowners and the organisations carrying out public works or industries in malarious areas. In the old Italian legislation, landowners, enterprises and public works administrations had to pay for the protection against malaria of the rural population and of their workers; now a new anti-malaria law is being planned under the terms of which landowners and firms of malarious areas are to be charged a special tax, the revenue of which will be devoted to the purchase of the material and equipment for DDT malaria control, the funds to be administered by the provincial Anti-Malaria Committees.

Why should the example of Greece and the proposal of Italy not be followed in other malarious countries?

Suspicion of a decreasing efficacy of residual toxicity.

While in Greece, I heard that rumours were spreading that this year DDT had not been so effective as last year. People living in properly sprayed villages complained that flies and mosquitoes had come back and they were inclined to blame the new method of utilizing emulsion instead of kerosene solution for this alleged ineffectiveness. The preparation of the emulsion by pouring water, in public, onto the DDT concentrate, had certainly made people suspicious about this "watering down" and dissatisfied because of the absence of the smell of kerosene with which they were used to associate the dramatic results witnessed the year before. No doubt this psychological attitude unduly magnified the decrease of efficiency, if any such decrease existed. But Medical Officers of Health appeared to share
somewhat the belief of the population; and Major BIERSTEIN and myself were rather surprised to find a large number of flies in a country inn where we stopped for lunch in a village of Attica, and a few Aedes calmly resting on the wall of a bedroom which had been sprayed two months before.

But in peninsular Italy, especially in the province of Latina, the dissatisfaction of the population was just as pronounced as in Greece, and here we could not account for it by attributing it to suspicion aroused by the watering down of the concentrate, for in this area the same kerosene solution was used as in previous years with the same technique and with the same organisation. True, the dramatic surprise caused in previous years by the disappearance of flies, mosquitoes, bed bugs and even fleas among a population which had always been accustomed to being annoyed by hosts of insects has made everybody very keen at spotting any insect coming into the house; but it is difficult to believe that this psychological attitude can explain all the rumours which became so widespread that Prof. MISSIROLI had to give a press conference to tranquilise the people and to stop the criticisms appearing in the press.

The very fact that these rumours had arisen in regions where DDT had been utilized a year or a couple of years before, while in areas where DDT was applied for the first time, as in Sardinia, people were enthusiastic about its wonders, is rather disquieting, especially if we consider it in the light of some recent observations. While in Italy Dr. SACCA, an entomologist working with Prof. MISSIROLI, showed me some house-flies captured by him near Anzio, which survived long exposure to surfaces treated with DDT, after they had shown signs of intoxication. In Sweden, a strain of house-fly found in the vicinity of Arnäs, showed the same behaviour and it is suspected that this strain has replaced the house-fly population sensitive to DDT in the North of Sweden, because attempts at house-fly control in that part of the country have not given satisfactory results. (Unpublished communication by Dr. WIEMANN, entomologist of Geigy’s Laboratories). Similar observations have been made also with mosquitoes – strains of Aedes in England, I believe, strains of Culex pipiens in Italy. I do not know of any observations of the kind having been made with Anopheles labranchiae or A. alutus, but one cannot

(1) Even the dose of DDT x sq. metre is of the same order; in 1947, as a matter of fact, it was higher (grammes 1.835) than in 1946 or 1945 (grammes 1.75 and 1.73).
forget that Dr. MUIRHEAD THOMSON found in Lagos that DDT proved ineffective against A. gambiae, because this mosquito became so quickly irritated after having absorbed minimal doses that it would soon abandon the walls and survive. One cannot help recollecting the history of the sulphonamides and of the gonococcus, and one wonders whether the application on the walls of insufficient doses of DDT would not constitute a danger in the long run, in so far as it would allow the survival of the more resistant individuals and thus bring about selected strains. (1) After all, we know that resistant strains develop by natural selection in agricultural practice with insecticides.

Part that the WHO could play with a view to assisting countries in DDT malaria control.

In countries where anti-imago campaigns with DDT are carried out, malaria workers are enthusiastically convinced that at least there is a method economically feasible which will result in reducing malaria transmission to insignificant levels. Sharing their views, one cannot refrain from visualizing what these results would mean for the rural population whose energy had for centuries been sapped by malaria. Besides, as it is often said, DDT, by controlling house-hunting insects also would lessen insect-borne diseases and lower infant mortality. The benefits to public health would be associated with marked improvement of the working capacity of the population and of their earning power, so that DDT might well be considered as an important instrument in rural reconstruction.

It seems therefore that the WHO,IC— as well as the WHO once it is in existence— should do everything possible to help countries desirous to carry out malaria control by means of DDT. Such assistance should aim at improving the organization and the technique, and at reducing the costs. The following points might be considered:

a) Even if it cannot yet be decided whether, in certain circumstances, larval control should, or should not, be associated to anti-imago campaigns, house-spraying is to-day the fundamental method of applying contact insecticides. Now a proper organization, adequate training of the workers and the right equipment will mean economy as well as efficiency. In the province of Latina,

(1) Recent information kindly communicated by Dr. J.M. VINE, Chief of the WHO,IC Mission in Greece, is rather interesting in this connection, for it states that in Greece no complaints of alleged inefficacy of this year's house-spraying have come from certain districts, for instance, from the island of Chios.
during the first campaign undertaken by UNRRA in 1945, the average surface treated per man-hour was 34 sq.m.; in 1947 it rose to 209 sq.m. The experience gained by malaria workers in the present campaigns should be made available to countries embarking upon the same venture.

b) In its Report, the Expert Committee drew attention to a recently observed tendency to increase the price of DDT in the market and suggested that steps be taken "to advise the entities concerned to give consideration to this problem." It would also seem advisable that commercial DDT should conform to certain characteristics, not only as regards its chemical composition, such as content in para-para compound, but also as regards physical properties, for it has been mentioned in these notes that some consignment of DDT showed great difficulty in being dissolved in kerosene, and that consequently their use was more expensive.

c) Encouragement should be given to the study of the question of the application of suspensions of DDT instead of emulsions or solutions; and as regards emulsions, it might be advisable to suggest to the different malaria control organizations whether the preparation of the concentrate carried out by themselves would not be cheaper than importing it in barrels from the producers.

d) The WHO. IC would render a great service in the countries where DDT malaria programmes are being carried out, by offering to the men in charge of these programmes the opportunity of visiting their colleagues in other countries. It seems that if Greek workers could study the programme of peninsular Italy and Sardinia, and that if the workers on these programmes could become acquainted with the Greek programme and even with that carried out in other Italian regions, great benefit could ensue. Some of these malaria workers might further be invited to a meeting attended by one or two experts from other countries, at which they could discuss problems of mutual interest.

e) During my visits some field workers raised the point of the benefit that they would derive by an exchange of information on malaria control by means of insecticides, and added that they would welcome the WHO. IC Secretariat acting as a clearing centre of recent technical news which otherwise would probably not reach them until much later.

f) For countries proposing to set up a residual spraying scheme or a composite programme of malaria control, the WHO. IC might envisage the opportunity of lending to the Governments concerned, if they would wish it, the assistance of experts in the organization of the campaign, due consideration being given in advance to the planning of
comparison areas and the gathering of reliable data with a view to assessing the value of the technique applied and to being able later to select the best for the country. It may be found that the best means of providing expert assistance would consist in offering the service of a team composed of a malarialogist, an entomologist and one or more sanitary engineers and provided with the necessary equipment and material.
Italy
Sardinia
1:3,000,000

Area of the island in which antilarval campaign is being carried out in 1947

High mountainous non malaria areas, which have not been covered by the anti-image campaign

Italy
Provinces of Frosinone and Latina
1:1,250,000

Greece
1:6,000,000
THE DDT ANTIMALARIA PROGRAMME IN GREECE

(28 May - 3 June 1947)

In Greece (surface: 130,000 sq.km., population: 7,200,000) the malaria epidemic season lasts six months (15 May to 15 October). It is well-known that a characteristic of the epidemiology of malaria in Greece is its endemo-epidemic rhythm conditioned chiefly by meteorological factors, rainfall and summer temperature; every 3 to 5 years, a year or a couple of years; occurs which is attended by severe and widely spread morbidity, followed by a series of years in which the incidence and the seriousness of malaria gradually decrease. The last epidemic year was 1942; prior to this, 1935-36 and 1931-32.

The malaria vectors in Greece are, in order of importance *Anopheles elutus*, *A. superpictus* and *A. maculipennis* (var. *typicus* and *subalpinus*). *A. elutus*, the most anthropophilic of the three is the transmitter in the plains, particularly in the coastal region, on account of the preference of its larvae for brackish water, although they are also common in fresh water in the interior of Greece, water is always slightly flowing.

The curves of mosquito prevalence show a maximum of *elutus* and *maculipennis* in the month of June and July and a maximum of *superpictus* in August and September. The first generation of the two first species appears in April and infected *elutus* have already been found in May; the first generation of *superpictus* appears in July; larvae of *superpictus* begin to be found in July, exceptionally in June, and reach the peak in July and August.

The malaria control in Greece is entrusted by the Ministry of Health to the School of Hygiene which was set up in 1930. Its first Director was Dr. Norman WHITE, formerly of the Health Section of the League of Nations. Its present Director is Prof. G. LIVADAS who also heads the Malaria Division. The Chief Malaria assistant is Dr. GHEORGHIPOULOS, who is directly responsible for the work in Crete. Other malariologists of the School (Dr. BELIOS, Dr. G. POURNAROPULOS and Dr. G. FAMELIARIS) have the responsibility of some particular region of the country. The entomologist of the School is Dr. HADJINICOLAU, who had just returned f.om a year's travel in the USA and London.

In the prefectures, or "nomoi" (47) malaria work is entrusted to the Medical Officers of Health, one for each "nomoe". Each of these "nomiatro" is assisted by a malaria inspector trained in the School of Hygiene, appointed for the region, and has his own malaria control team. The "nomiatro" are responsible for the administrative and financial aspects of the campaign.

DDT was first employed in Greece in malaria control in 1945 (summer and autumn) when preliminary work was carried out. UNRRA having taken over the functions of the military Liaison Service, helped in re-organizing the antimalaria organization of the country. The school of Hygiene dealt with the administrative
while the Malaria Control and malariological aspects of malaria control/Section of UNRRA dealt with the engineering and the supplies. Thus, UNRRA lent American sanitary engineers — generally of the US Public Health Service — to work in each of the eleven departments into which the country was divided and to which one Greek malarologist and one Greek engineer has been assigned. Colonel D.E. WRIGHT, the well-known American sanitary engineer, whose career had started in 1904 with General Gorgas in Panama, and who had spent many years in Greece with the Rockefeller Foundation mission, was now back with UNRRA. Experimental work was carried out first in 1945 in some areas of Attica, Beotia and Peloponnesus, by house-spraying methods. LIVADAS, BELIOS, and ISSARIS have reported upon this experiment (Adult spraying with DDT — Experim. applic. Athens, 1946). Nothing more than an experimental application could be made on account of lack of previous experience, scarcity of DDT and shortage of other necessary supplies.

In 1946 UNRRA had in Greece — or was bringing over — a great amount of DDT equipment and means of transportation and was in a position to offer skilled supervision in the antimalaria campaign. According to a plan drawn up by Col. WRIGHT, a nationwide campaign was started. The School of Hygiene supplied malarologists, Greek sanitary engineers and labour, UNRRA supplied the material and skilled sanitary engineers. Originally, the programme was scheduled as follows:— 1) spraying of all possible shelters of hibernating anophelines; 2) spraying in the summer of houses missed during the previous spraying, or where insects had reappeared; 3) as soon as larval breeding began, hand-spraying of all breeding places within a radius of 5 kms from the outskirts of the village to be protected; 4) air-spraying of large or inaccessible breeding places.

But the execution of this plan was beset by unpreventable difficulties and delays, so that phase 1) dove-tailed into phase 2) and house-spraying was not completed until the end of September. By that time, 3,870 villages comprising 700,000 houses had been sprayed, whereby 3,150,000 inhabitants were protected. (According to figures given by LIVADAS for 1940, there were in Greece 11,000 villages, in 5,000 of which there was a serious malaria problem). A strict supervision was maintained of the houses sprayed before the beginning of the malaria season; where mosquitoes were present, they were sprayed again according to the plan; but only 6% of the houses needed this second treatment. Larval control by air was started with a view to covering 113,000 acres (out of a total of 250,000 acres of marshland) which larval surveys had shown to be dangerous. By the end of the summer, the area to be treated had shrunk to 80,000 acres, The mean of these extreme figures being 96,000 acres (38,000 ha.) and the total surface covered during the season by air-spraying having been 506,356 acres (202,540 ha.) these 96,000 acres have thus been sprayed 5.3 times. Apparently, Col. WRIGHT, when drawing up his plan did not aim at the eradication of anophelines from Greece; his first aim was to control malaria, the second to curtail drastically the anopheles population with the hope that, by maintaining house-spraying, they would never reach again the previous high density, and the third, to protect from infection individuals sleeping out of doors. The two last aims prompted the inclusion of larval control in the plan.
A total eradication of Anopheles was, on the contrary, envisaged for the island of Crete. Unhappily, political difficulties interfered seriously with the execution of the 1946 programme in the island.

The 1947 Programme

ORGANIZATION

The campaign is carried out by the Government under the direction of the School of Hygiene, Division of Malariology, with the collaboration of the WHO-IC Greece Mission headed by Dr. J.M. VINE (in which three officers: Col. D.E. WRIGHT, of the Rockefeller Foundation, Maj. P. BIERSTEIN, Sanitary Engineer, and Mr. H.E. LOWRY, airplane mechanic, deal with malaria).

The campaign involves house-spraying and larval control, by hand and by air.

a) House-spraying is applied to all buildings of every town, village or hamlet, with a population not exceeding 6,000 inhabitants, in malarious areas. All premises are treated the walls being sprayed from the floor to the ceiling, and the ceilings being also treated, irrespective of their heights.

In the towns with a population above 6,000, house-spraying is limited to a belt of buildings on the outskirts of the town. In the largest towns of the country, as for example in Athens, house-spraying is limited to buildings for which it is indicated for general insect control; slaughter houses, dairies, restaurants, markets and garbage dumps. As there are in the vicinity of Athens some mosquito breeding places of importance (which in former years were regularly treated with Paris Green), they are now hand-sprayed with DDT.

DDT is applied as follows:-

1) in the case of houses, in the form of a 5% emulsion, prepared locally by diluting with water the 26% concentrate;

2) in the case of stables, out-houses, warehouses, etc. in the form of a 5% Diesel oil solution, prepared by diluting the 20% concentrate in Velsicol, used for air-spraying.

In both cases, the amount of DDT per sq. m. is reckoned to be about 2 grammes. The men employed are trained and supervised by the Malaria Inspectors, of the Malaria Division of the Athens School of Hygiene. They are distributed into teams, each consisting of two or three men with a foreman. Where houses are not too widely apart from each other, such teams can spray 30 houses per day on an average, with a total surface of 7,000 to 7,500 sq. m. Hudson industrial spray pumps are used, without any alteration, with fan-shaped spray ... nozzles. The teams carry a set of pumps for the emulsion and another one for the Diesel oil solution.
House spraying began in March and it will come to an end before July. Up to the time of my visit, 2,500 villages had already been treated.

We were able to see house-spraying operations in Spata, a village of 5,500 inhabitants, where two teams were working on the day of our visit. The man spraying the barns and the stables with Velsicol solution diluted with Diesel oil, were very wet from the mist sprayed and from the liquid from the pump. They showed large patches of erythematous-papular dermatitis on their hands, shoulders and knees. Their shirts and trousers were soaked and apparently they were not used to wash themselves with water and soap after the work. The solution is certainly irritant; we felt it very distinctly on our face after a few minutes' exposure to the spray.

b) Larval control

1) Hand-spraying. Repeated every 12 days, is carried out by means of small Hudson flit-type sprayers No.401 of one quart capacity. A 0.1% DDT emulsion is used, one litre per 50 sq.m. i.e. 0.02 gramme DDT per sq.m. The emulsion is prepared by diluting the 26% concentrate with water.

2) Air-spraying. There are, this year, 12 air-spraying centres and the DDT fleet consists of 17 aircrafts (Stearman biplanes) operated by Greek pilots of the Greek Air Force. The 20% solution of DDT in Velsicol is used at the rate of 1/2 pint per acre, i.e. about 0.012 per sq.m.; spraying will probably be repeated this year every 15 to 17 days. As this period exceeds the duration of the aquatic life of anophelines in Greece during the summer, this surmises a residual action of DDT on the water which has been reckoned at 5-6 days. The solution is ejected in the form of a thermal aerosol. A special propeller operates a pump which sprays the Velsicol solution into a "venturi" that is, into a pipe through which passes the exhaust of the engine, at a mixture caused by two opposite cones. An airplane can spray 17 acres (ha.0.8) during one minute flight. It has been calculated that the cost of spraying 10,000 sq.m. is $0.40 by airplane, against $3.60 by hand.

During the month of May 1947, a total surface of 152,300 acres (61,620 ha.) has been sprayed by airplanes with 8,960 gallons (33,113 litres) of 20% DDT. This means that the average was litres 0.55 per ha. or pints 0.44 per acre. (If the Velsicol solution was made up of 20 grammes DDT per 100 cc. of the final solution, the DDT sprayed per sq.m. would have been 0.011 grammes).

The first air spraying was done this year on the first of April and it is intended to do the last approximately on the 15th of October (last year the last spraying was done at the beginning of November, but it had been impossible to follow a rational periodicity of the spraying owing to several unpreventable circumstances.)
A demonstration of air-spraying was attended in the Nea Marmi swamp. This swamp, which had been one of the theatres of the Rockefeller Foundation experimental malaria control, as indicated by a memorial column erected to John D. Rockefeller, had been controlled by the Foundation by means of drainage. During the war, the drainage was neglected; in 1946, DDT was applied by plane, as it is this year. The skill of the pilot was remarkable. In order to show his technique properly, he flew over the marsh several times, repeating the swaths, so that an amount of aerosol largely exceeding the necessity was sprayed. Iridescent films of Velxicol were easily visible all over the surface of the water, where anopheline larvae were present. Larvae collected after the spraying were still alive and did not show any sign of intoxication three hours later.

Among the difficulties encountered in carrying out the 1947 programme are the following:

1) The present political conditions of the country with the state of guerilla warfare in many regions;

2) The lack of the necessary number of well-trained malariologists and sanitary engineers, for the supervision of the work; in many regions, this year, there are no malariologists, but the "nomiatrol" assisted by a chief malaria inspector are in charge of the work while last year for every department, there was an American trained sanitary engineer, as well as a Greek Sanitary Engineer; this year there are only Major BERSTEIN the American member of the WHO. IC mission, and three Greek sanitary engineers.

3) All the UNRRA means of transportation having been given over by UNRRA to the Greek Government, the malaria control service cannot avail itself of all the motor facilities they had last year.

c) Experiments under way

1) In Crete.

This island is particularly interesting for two reasons: (1) because the campaign may be considered as an attempt to eradicate anophelines; (2) because it shows already that the population can actively collaborate in a DDT house-spraying malaria control campaign.

The island is divided into four prefectures or "nomoi" each "nomos" consisting of some provinces and each province being divided into "team units", that is, in areas which can be treated with DDT against adults as well as against larvae, by a team composed of a foreman and 3-6 men. The methods of house-spraying are the same as in the rest of Greece; house-spraying was intended to come to an end before July 1st and after that date all efforts were to be concentrated on larval control.
While in Greece the communities limit themselves to give food and lodgings to the spraying teams, in Crete the communities go further in contributing directly to the financing of the campaign by paying the salaries of the workers besides giving them food. This system was already introduced last year and it proved successful. The foremen, who are considered as fixed employees, are not paid by the communities, though these offer them food and lodging, but the Government pays them at the rate of 7,500 dr. daily ($1.50). Last year they received and additional bonus of 2,000 dr. a day from the Greek War Relief. The foremen employed in Crete seem to be very well-trained and reliable and this explains their better pay. They were recruited last year by UNRRA from among gymnasi um graduates who had applied to UNRRA following announcement published in the press. The selected one attended courses for two or three weeks and were eventually appointed if they passed the examination at the end of the training.

2) The Gammexane experiment.

This experiment is being undertaken under the leadership of Dr. HADJINICOLAU in the sea coast village of Aghii Apostoli on the gulf of Eubea. Here all the houses have been lime-washed before the transmission season, the last layer of lime-wash containing 200–400 mgrs. of gammexane per sq.m.

A visit to the village revealed that the musty odour of gammexane was still very evident in spite of the fact that several weeks had elapsed since the spraying. No mosquitoes were found in the houses during our visit, and only one was found in the four control stables. A visit to the breeding places nearby, a swamp and a slow stream running into the sea, showed a few larvae of *maculipennis*, one larva of *supercinctus* (a very early finding of the 31st of May) but a great density of larvae of *A. algeriensis*. This last finding may explain why the inhabitants of the villages complain of being bitten by mosquitoes outside; they state that they are also bitten by mosquitoes and moles ted in the houses.

3) Messini (Kalamata)

A unit of the US Navy Epidemiological Section stationed for some time in the Messini area, on the south coast of the Peloponnesus, left there some trained personnel in order to help the School of Hygiene in carrying out experiments. Three areas were selected, very similar to each other; in all three there are rice fields and many other breeding places. The area of Messini will be treated only by house-spraying. The Asprichoma area will have its breeding places treated by air-spraying only (every 17 days). The Aris area, where no DDT will be utilised, will constitute the comparison area. Every area has a radius of 3 kms.

(*) see map
Thorough observations on malaria morbidity and on anophelism will be made. Larvae-catching stations and capture stations in stables and in kegs left in the open will be regularly operated. The villages had been previously surveyed. In each area, there is a malaria dispensary where paludrine will be tried as follows: in the case of *falciparum* infection, one single dose of one tablet; in the case of *vivax* and *malaria* infections, 3 tablets a day for 10 days or for 21 days. All the patients have their blood examined daily.

This experiment is under the direct supervision of Dr. MAVROMICHALIS, stationed in Kalamata, assisted by two Greek malaria inspectors and by three American Marines.

FINANCING

The Greek Government has budgeted about £300,000 for the 1947 campaign. Moreover, the Greek Government participates in the expenses of the WHO.IG mission in Greece (about 50%) and the Rockefeller Foundation pays the salary of Col D.E. WRIGHT. The DDT and concentrate used this year are still those given by UNRRA to the Government. The price of this material has been calculated as follows:—

<table>
<thead>
<tr>
<th>Material</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDT per pound</td>
<td>£ 0.50</td>
</tr>
<tr>
<td>Diesel oil per metric ton</td>
<td>£ 74.50</td>
</tr>
<tr>
<td>DDT 5% in Diesel oil, per gallon</td>
<td>£ 0.35</td>
</tr>
<tr>
<td>DDT 26% concentrate, per US gallon</td>
<td>£ 2.60-1.80</td>
</tr>
<tr>
<td>id., diluted 1:5 in water, per US gall.</td>
<td>£ 0.35 app.</td>
</tr>
<tr>
<td>Velsicol alone, per gallon</td>
<td>£ 0.46</td>
</tr>
<tr>
<td>Kerosene, per can (1,280 cc.)</td>
<td>£ 0.16</td>
</tr>
<tr>
<td>5% DDT in Kerosene, per gallon</td>
<td>£ 0.40</td>
</tr>
</tbody>
</table>

The Stearman planes P.T.17 were quoted at £ 2,500 each, being surplus material of the army, i.e. a total of £45,000 for the 18 planes (there are 17 now, one having been wrecked). The total value of aircrafts as calculated in 1945 was as follows:—

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planes</td>
<td>£ 45,000</td>
</tr>
<tr>
<td>Spare parts</td>
<td>£ 33,640</td>
</tr>
<tr>
<td>Tools</td>
<td>£ 5,484</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£84,124</strong></td>
</tr>
</tbody>
</table>

The spray-pumps of different makes average in price eleven dollars (similar sprays constructed in Greece were sold at £120.—) A Hudson "flit type" spray No.401 costs 40 cents.

Salaries of the workers. As the malaria control is a Government undertaking, the workers' salaries cannot exceed the Government rates. Therefore, unspecialized workers are paid 5,000 Dr. and the specialized workers get 7,000 Dr. per day. These salaries are much lower than those that could be obtained from private enterprises; however, the situation is substantially improved thanks to the initiative of Prof. LIVADAS, who succeeded in
obtaining from the communities that meals and lodging be supplied free of charge to the teams spraying the houses of the locality. This system has been agreed upon all over the country in 1947. When the workers are no longer needed for malaria work, they are dismissed. This year, however, most of the men employed the year before were engaged again in malaria control.

In Attica, (1) where all the malarious villages had already been sprayed at the time of my visit, a team composed of one foreman and three men employed 4 days (including the time required for transportation) for the spraying of 100 houses, corresponding to about 550 inhabitants, and the following material:

26% DDT concentrate: Value Dr .......... 365,000,—
Salaries: " .................... 120,000,—
Transportation (35 kms) " .......... 87,000,—
Supervision: " .................... 13,000,—

Dr. Total .. 585,000,—

which amounts to about 1,000 dr. per capita.

If we add the value of the food given by the community to the workers, estimated at Dr.112,000,— the total cost would reach the sum of Dr. 697,000,— i.e. 1,300 Dr. per capita, i.e. 26 US cents.

Cost of the campaign in 1946, according to Dr. LIVADAS'

Population protected: 3,600,000
Government budget for the campaign: £ 360,000, i.e. £ 1,440,000, i.e. per capita: 2 s. or 0.40

If the value of the material supplied by UNRRA is taken into consideration, the total budget would amount to £437,500, i.e. £1,750,000: Cost per capita 0.436. These costs appear very high, even in comparison with larval control by Paris green as carried out in Greece formerly when the average annual cost per capita was, for instance, as high as 0.32 in the village of Mourni but as low as 0.034 in the town of Drama (BAUS, 1936).

It is expected that these costs will be reduced in 1947 and in future years because: (1) emulsion will be used instead of kerosene solution; (2) there will be, according to Prof. LIVADAS, the possibility of perfecting the organization and avoiding wastages; (3) there is the hope that the communities will pay for the labour, as it happens already in Crete.

RESULTS

There is no doubt that during and after the 1946 DDT

(1) Population: 1,450,000, 1,200,000 of which in Athens and Pireaus.
campaign the malaria incidence in Greece was greatly reduced. In Salonika, for instance, the Malaria Laboratory was closed down because there were practically no more suspicious blood-slides to be examined.

All over the country, deaths caused by malaria were reported to be extremely rare; blackwater fever cases had been absent for some areas where they used to occur; preliminary reports showed that malaria cases in 1946 revealed a remarkable low proportion of *P. falciparum* infections; and when these findings will be duly documented by the examination of all the blood slides collected in 1946 (the greater part of which is still under way both in Athens and Salonica), a low proportion of *falciparum* will be a sure sign that transmission in 1946 was at a low level.

It is well known, however, that with the endemo-epidemic type which characterizes malaria epidemiology in Greece, there always are years of low transmission, and that every 3 to 5 years, transmission increases so acutely that malaria becomes nearly epidemic. Is it possible that 1946 was naturally a year of very low endemicity? According to the opinion of a great authority on malaria in Greece, Prof. LIVADAS, the year 1946, if not an epidemic one, was certainly not a year of particularly low transmission; it seems, therefore, plausible to attribute to the DDT campaign the low level of malaria incidence in 1946.

Greek malarialogists have tabulated spleen and parasite rates for some treated and untreated areas and copies of these tables have been annexed by Dr. VINE to the paper he presented recently to the Royal Society of Medicine. One of the most demonstrative of these documents is a table referring to eight villages along the Sperchios river. Seven of these villages had been sprayed in 1945 - but late from July to October - and in the pre-epidemic season of 1946. One village, Rodonia, was not sprayed, being left as a control. Spleen and parasite rates were taken in the autumn of 1945 and the autumn of 1946.

To summarize the evidence given by this table, the average (weighted) rates can be calculated for the total population examined in the seven villages and compared with the rates in Rodonia.

### Average - *(weighted)* Rates for Seven Villages, Sperchios Area

<table>
<thead>
<tr>
<th></th>
<th>Spleen Index</th>
<th>Parasite Index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1945</strong></td>
<td><strong>1946</strong></td>
<td><strong>1945</strong></td>
</tr>
<tr>
<td>Villages sprayed</td>
<td>59.9 43.3 -28%</td>
<td>21.8 6 -72.5%</td>
</tr>
<tr>
<td>Comparison village (Rodonia) unsprayed</td>
<td>54 66 +22%</td>
<td>24 33 +45%</td>
</tr>
</tbody>
</table>

Moreover, while in 1946, out of 99 babies born after the epidemic season of 1945, and whose blood was examined, not one was found infected in the villages treated, in Rodonia, out of
ll babies examined, one was found infected.

Unluckily, most of the other tables available, and annexed to Dr. VINE's paper, while showing a sure decrease of transmission in 1946, lack - as Dr. VINE has aptly remarked in his paper - the necessary comparison areas which would allow to decide whether this decrease of endemicity is due to DDT. The drops in spleen rates are certainly remarkable, but it might be said that, formerly, in villages of Thrace and Macedonia where no malaria control was carried out, the spleen index sometimes fell from one year to the next as much as 26% from 1933 to 1934, in a group of 19 villages (see LIVADAS "Malaria in Greece", 1940 page 134) and as much as 32% (from 1937 to 1938 in the same villages). But, as we have said before, 1946 was not supposed to be a year in which transmission was lower than in 1945; and the Sperchios river area gives data to support this assumption. Moreover, these spontaneous falls in the malaria indices generally follow an "epidemic" year and we gather that 1945 or 1944 (for which unluckily no data are available) were not considered to be such. Therefore, there is reason to believe that also the diminution of rates given in most of the above-mentioned tables are due to the effect of DDT, provided that atesbrin, largely brought into Greece in 1945, was not widely used by the population.

It will perhaps be more difficult to ascertain what influence DDT had on fly-borne diseases like dysentery. The fact that in 1946 there were 489 notified cases, as against 2,516 in 1945, appears to be impressive; but we find still greater differences in the figures of dysentery morbidity in other countries, such as the Netherlands (2,593 in 1945 and 355 in 1946) and in Austria (22,144 in 1945 and 1,369 in 1946), where DDT, as far as we know, was not employed on a national scale.

Malarialogists will probably regret that such a nationwide malaria control campaign as that carried out in Greece could not provide them with a greater wealth of precise data; but they will understand that the campaign was meant to give the best possible results to the largest number of inhabitants. It was an emergency measure for a country which had had so many sufferings in the previous years that when it was found possible to relieve it at least of one of its plagues, it would have been unfair to leave aside comparison areas. And it would also have been inhuman not to distribute widely the large supplies of atesbrin that UNRRA gave at the end of 1945, but which adds to the difficulty of assessing the DDT efficacy in the campaign. However, in due time, some useful data will be available, such as the malaria death rates for 1946, the results of the tens of thousands blood slides which are still being examined, etc. Also, data collected this year will probably help efficiently in assessing the value of DDT. But it seems that also 1947 will not be an "epidemic" year, for the entomologist of the Athens School of Hygiene is of opinion that the density of anophelism was not going to be intense. The winter had not been very wet,
and the spring was exceptionally dry, in fact, there had been no rain from March to June; besides, the captures of anophelines made in different parts of the country support his opinion. Nevertheless, it is possible that the climatic conditions will favour a higher prevalence of A. superpictus in the late summer.

The reaction of the population to DDT spraying has been very favourable in Greece, so much so that it induced the communities to collaborate substantially in the campaign by offering meals and lodgings to the workers and, in Crete, even by paying the workers' salaries. But this year (1947) there were widespread rumours that DDT was not as effective as previously. These rumours are generally ascribed to a psychological factor. This year, emulsion is being used instead of kerosene solution; emulsion has no odour and it is diluted with water in the villages actually being sprayed, so that the onlookers are prone to conceive that the teams dilute the stuff too much in order to be able to sell the unemployed material on the black market. Moreover, in 1946 — and in some areas already in 1945 — the attention of the population has been drawn to the insect problem so that everybody is now very keen in spotting mosquitoes or house-flies; it even seems that insect hunting constitutes a new amusement for children.

Nevertheless, one has the impression that these rumours should not be lightly considered and that the psychological factor alone cannot explain them altogether.

During my stay in Athens, Prof. LIVADAS told me that he often received telegrams from the medical officers of health of various "nomi" stating that DDT did not prove as effective as it should be, at least against flies.

While in Athens, and also in some villages visited, I found that house flies were almost absent. But during our trip to Nea Mαρί, we stopped for lunch at a village inn which had been sprayed about two months before, and we found a great quantity of flies all over the place though not on the walls. We captured a few of them in a glass which was held for half an hour against the wall! during that time, none of the flies developed any sign of intoxication, but we do not know what happened later. Then, in a bedroom of the same village we found three anophelines on the walls. The bedroom had been sprayed about two months earlier, and as we were in the room at about 11 o'clock a.m., these mosquitoes, very likely had entered in the early hours of the morning and had remained on the walls for 4 hours at least without being roused by the toxic action of DDT.

I understood that Col. WRIGHT and Maj. BIERSTEIN were going to carry out some experimental checking of the residual activity of DDT as employed this year.
THE SARDINIA ANOPHELES ERADICATION SCHEME

(9-12 June 1947)

In Sardinia the aim of the present campaign is to eradicate completely all anopheline species from the island which has a surface of 24,000 sq. km. (9,264 sq. miles) and a population of 1,190,000. The operations are carried out by a special organization called ERLAAS (Ente Regionale Lotta Anti-Anofelica Sardegna), under the jurisdiction of the High Commissariat for Hygiene and Public Health. Its headquarters are in Cagliari; its superintendent is Dr. J.A. KERR (of the Rockefeller Foundation) whose name is attached to the eradication of Aëdes aegypti in Brazil and of Anopheles gambiae in Egypt.

The operational Divisions of ERLAAS consist of:

(1) The Anti-imago Inspectorate charged with the DDT spraying work;

(2) The Anti-larval Inspectorate charged with the execution of the intensive island-wide operations which are essential for the eradication of anopheles;

(3) The Entomological Field Unit in charge of Dr. Thomas H.G. AITKEN, which is charged with studying the biology of anopheles, particularly A. labranchiae, and of making other special studies for the orientation of the work of the two inspectorates.

During the summer of 1946, under the auspices of the Rockefeller Foundation, Dr. AITKEN and Dr. CASINI examined 1,000 potential breeding places throughout the island with a view to determining the distribution of anophele larvae. The following species were found: Anopheles maculipennis labranchiae, spread all over the island, even at heights of 1,000 metres – practically the only vector; A. maculipennis melanon: A. claviger; A. marteri and A. algeriensis. Among the maculipennis captured last year 99% were labranchiae and only 1% were melanon. A. plumbeus was not found in 1946, but was picked up in the spring of 1947. Recently, Dr. AITKEN has found three specimens of A. superpictus which was not found in 1946.

The first DDT anti-imago campaign was started on 6 November 1946. By the end of June 1947, all houses, stables and other premises of malarious areas will have been sprayed, covering a population of about 1,100,000 out of the total population of the island amounting to 1,190,000. Until 1 June 1947, 2 grammes of DDT per sq. m. i.e., 40 cc. of the 5% emulsion were sprayed; since that date, in view of the few months during which a residual toxicity was
required, the quantity has been halved (emulsion diluted to contain only 2.5%) and they have refrained from spraying offices, stores, churches, staircases; schools, however, are sprayed, even if empty. As in peninsular Italy, wall spraying is done starting from a height of about 5 ft. upwards, for the mosquito vector does not rest on the lower parts of the walls. Ceilings are sprayed provided that they are not higher than 4 metres.

The anti-larval campaign in 1947 will cover only about one-fifth of the island. It started in May. Its chief purpose is the selection of the best technique and the perfecting of the organization of a campaign throughout the island, by means of which an attempt will be made next year to eliminate the last anopheles from the island. It was originally (February 1947) intended to use 5% DDT in oil plus three parts per thousand of Triton-X-100. Research made by the entomological service showed that instead of 10 mgm. DDT per sq. m., half the quantity was sufficient (50 grammes per hectare, i.e. 20 grammes per acre), therefore the solution now used consists of diesel oil (or fuel oil No.2) 100 litres; DDT commercial 2.5 kgs.; Triton X-100-0.75 litres. All percentages are calculated on the weight/volume basis. The addition of Triton X-100 to the oil enormously increases its spreading power. In one special test the application of 4 mgm of DDT per sq. m. sufficed to kill 99% of the larvae. All potential or real breeding places are sprayed once a week. The anti-larval campaign will come to an end this year on 30 September. The 1947-1948 campaign, aiming at anopheles eradication, will consist of:

(1) Anti-imago campaign, the house-spraying to be started on 1 October 1947;

(2) Anti-larval campaign, to be started in the spring of 1948 and to cover all potential anopheles breeding places;

(3) Careful surveys to ascertain the absence of anopheline larvae in 1949, and if necessary repetition of anti-larval campaign in regions in which anophelines might still persist.

ORGANIZATION OF ANTI-IMAGO AND ANTI-LARVAL OPERATIONS

The Provincial Anti-Malaria Committees, which formerly carried out malaria control with various means, including Paris greening, are now instructed to limit their activities to the treatment of malaria patients. All operations of malaria control are the entire responsibility of ERLAAS.

(*) see map
1. Anti-aegy Insectorate: Inspector, Dr. Guido CASINI (of the Institute of Malariology E. Marchiafava, Rome).

Three Divisions: one for each Province; each Division is responsible for a certain number of Sections; each section has a chief, 3 or 4 supervisors, a secretary, an accountant, a storekeeper and a typist; it works through teams consisting of 5 workers and a foreman, all recruited in the village or the town where the work is to be carried out. Teams are instructed and supervised by supervisors under direct orders of the Chief of Section and considered as regular employees.

Each section has the necessary means of motor transport and often hires horse-driven carts for carrying the barrels of emulsion to the houses if they cannot approach them by motor. Each section has an office and a store of material and equipment from which the necessary quantities are distributed to provisional "district" stores to which the team or teams can easily report before leaving for their daily work. Such district stores are generally made available by the municipalities.

The emulsion is prepared in these peripheral district stores and not in the place where the spraying is actually done. This has the disadvantage of increasing the bulk to be transported from the stores to the buildings to be sprayed, but has the advantage of preventing the concentrate from finding its way into the black market. Moreover, it would often be difficult in Sardinia to find the necessary water for preparing the emulsion in the vicinity of the houses to be sprayed, and the very fact of the emulsion being diluted with water in public might give rise to unpleasant commentaries.

Spraying is carried out with "Hudson Perfection No.210" pumps of a capacity of 14 litres, provided with a fan-shaped spray nozzle (manufactured by the Spraying Systems Company, Chicago, Illinois, U.S.A., Flat Atomizing Nozzle catalogue No.1/4 T 8002). These spray pumps have been slightly modified by ERLAAS as follows: the original outlet tube at the top of the spray pump has been removed and a threaded outlet tube placed in the wall of the cylindrical tank near the bottom. For general use the 70 cm. extension tube which is supplied with the spray pump, has been replaced by a tube 2 metres long, this tube being enclosed in a bamboo pole for greater strength.

Multigraphed instructions are available for the sprayers, the foreman and the district storekeeper.

To give an idea of the output of the work, we shall quote here some figures referring to the seven months period, November 1946–May 1947:
Premises treated per man-day: average 32
(Range 26-44)
Inhabitants protected per man-day: average 23
(Range 19-49)
Emulsion consumed per man-day: Litres average 37
(Range 32-53)
Emulsion consumed per inhabitant: Litre average 1.6
(Range 1.3-2.2)
DDT consumed per inhabitant: average grammes 80
(Range 65-110)

On 31 May, the population directly protected by means of house-spraying amounted to 806,237; DDT emulsion utilized: litres 1,318,719 (corresponding to litres 262,690 of 26% concentrate); premises sprayed: 1,068,525; man-days: 35,329.

Since the anti-imago programme comes to an end with the advent of summer, the number of house-spraying teams which reached a peak of 106 in May, has steadily been reduced, while the supervisors are progressively being shifted to the Anti-larval Inspectorate.


While the anti-imago house-spraying programme consisted in a slow moving march of teams through the island and the treated towns and villages, once treated disappeared from the picture for the present campaign, the anti-larval programme requires a weekly spraying of the breeding places for about 26 weeks, so that all the personnel remains attached to its apportioned area during the whole season. As in the Anti-imago Inspectorate, the Island will be subdivided into Divisions. The region of Sardinia which is being treated against larvae this season is the South-Western area. The Divisions consist of a certain number of sections, each with its office and its store; the Chief of every Section, assisted by three or four supervisors, is the head of two services: the larvicid service and the service entrusted with the control of results by means of "larva scouts" (about six for every section), trained to search for larvae in all potential breeding places. The Section Chief directs them, according to a secret programme, to inspect the various sectors of the section. The larva-scouts report directly to the Section Chief or to the Division Chiefs.

The Anti-larval Inspectorate also has teams of "imago-scouts" (i.e., men trained to search for mosquitoes in treated or in controlled places). They work under foremen (5 scouts and a foreman constitute a team). The foreman reports directly to the Section Chief. However, only a few imago-scouts were at work and their final position in the whole organization is still being studied.

(1) see map.
Each Section is subdivided into Districts. The District Office, with the District Store is located in the centre of the area to be treated. The Chief of the District is responsible for the training of the larviciders and for the supervision of the work. He outlines the itinerary of every larvicider for every day of the week.

Every District is subdivided into 4-8 Sectors, each Sector having an area of about 10 sq. km. The Sector is the individual unit, all of which can be sprayed during the six working days of the week by a single larvicider who is directly responsible for his work.

Larviciders wear a special uniform with tropical helmets, so that they can easily be spotted at a distance. Moreover, they mark with a special flag the area in which they are working. Every Saturday afternoon the larviciders report at the District Office. Each larvicider sprays about 3 litres of solution every week. Theoretically, one litre of 5% DDT in oil should suffice to spray a hectare (10,000 sq. m.) at the rate of 5 mgm per sq. m.; but often this suffices only for 6-8,000 sq. m. For the spraying of large extensions of water the Hudson Perfection Spray Pump is used but it is fitted with an "Atomizing Nozzle" manufactured by the Spraying Systems Company, catalogue 1/4LNL. For ordinary small breeding places continuous action hand-sprayers of the "flit-gun type" but with a capacity of about one litre, also manufactured by the Hudson Company, are used. When these sprayers are from 1/4 to 3/4 full they deliver about 1.3 cc. of DDT oil per full stroke. The larviciders are instructed that one full stroke is sufficient for 5 sq. m. of breeding place of 2½ sq. m. if the water surface is covered by abundant vegetation. The mist must be so directed that it can be further dispersed by the wind.

The total area of the island being 24,000 sq. km, it was calculated that 0.5% of such an area, i.e., about 120,000,000 sq. m. represented the surface of potential breeding. For 25 weekly sprayings, at the rate of 5 mgm per sq.m., 15 tons of pure DDT will be required. It was originally calculated that on an average it would be necessary to have a larvicider for every 10 sq.km. i.e. 2,400 for the whole island which will be divided into 500 Districts, each with 5 larviciders and a foreman who is the Chief of District. The 500 Districts will be grouped in 24 Sections. Multigraphed instructions are provided for the Chief of Anti-Breeding District, for the larva-scouts and their foremen.
TRANSPORT

The ERLAAAS has at its disposal:

- Heavy load G.M.C. trucks ......... 17
- Dodge trucks ................... 126
- Diamond crane truck ............... 1
- Jeeps .......................... 47
- Fiat touring cars .................. 2
- Trailers for Dodge trucks ....... 50
- Trailers for jeeps ................. 25

FINANCING

"Lire Fund", i.e. funds obtained by the Italian Government by selling UNRRA goods, in agreement with UNRRA.

Budget: October 1946 - December 1947

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount (million lire)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946</td>
<td>300</td>
</tr>
<tr>
<td>1948</td>
<td>1,069</td>
</tr>
<tr>
<td>1949</td>
<td>215</td>
</tr>
</tbody>
</table>

Total: 1,584 million lire

To this sum must be added the material given by UNRRA, evaluated at 780,000 dollars (about 175.5 million lire at the official rate of exchange of 225 lire to the dollar).

The 1948 budget was prepared as follows:

(February 1947)

- General Direction, Rents, Office and Mail Expenses ............... 119.9 million lire
- Transportation: operation and repairs... 91.9
- Anti-imago operations (Personnel)........ 69.5
  (the material having been given by UNRRA for the 1947-8 programme)

Anti-larval operations:

(a) Personnel.................. 471.8
(b) Personnel for minor drainage work........ 16.5
(c) DDT, Oil, Triton, pumps and uniforms for the 1948 programme 85.6

Total: 855.2 million lire

If a third anti-imago campaign in 1948-49 were necessary, the required material would cost............... 214.

Total: 1,069 million lire
**Note:** Cost of material and equipment in Italy (February 1947):

<table>
<thead>
<tr>
<th>Material/Equipment</th>
<th>Price (Lire)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDT (made in Italy) per metric ton</td>
<td>1,500,000.-</td>
</tr>
<tr>
<td>Kerosene</td>
<td>40,000.-</td>
</tr>
<tr>
<td>Grude oil</td>
<td>40,140.-</td>
</tr>
<tr>
<td>Triton-X-100</td>
<td>1,500,000.-</td>
</tr>
<tr>
<td>Spray Pumps (Flit type) each</td>
<td>500.-</td>
</tr>
<tr>
<td></td>
<td>(Hudson Perfection)</td>
</tr>
<tr>
<td>26% DDT concentrate, F.O.D. Naples per metric ton</td>
<td>600.-</td>
</tr>
</tbody>
</table>
III

THE DDT HOUSE-SPRAYING CAMPAIGN
IN THE PROVINCE OF FORSINONE
(16-17 June, 1947)

The province of Frosinone, S.E. of Rome, sustained the brunt of the war in 1944. Before the war, most of it was not malarious, except for a small zone approximately in the centre of the province, around Ceprano (see map). During the advance of the Allied troops, after the long fights along the Greigliano and Liri rivers, and the battle of Monte Cassino, epidemic malaria broke out. 1945 was attended by a steady malaria morbidity and mortality. Chief vector: A. maculipennis labranchiae.

An idea of the seriousness of this epidemic can be conveyed by the spleen and parasite rates collected in March 1946 (see Table). House-spraying had been carried out for the first time in 1946 in most malarious areas of the province, and UNRRA had done it in September 1945 in the Cassino region.

ORGANISATION

In 1946, the Antimalaria Committee of the Province was placed under the direction of a Malaria Control Commissioner, Prof. G. RAFFAELE, of the "Institute of Malariology E. Marchiavala", in Rome; Dr. A. COLUZZI, of the staff of the same institute, is in charge of the field work. The Province was divided into three areas, roughly from N.W. to S.E.; Dr. COLUZZI is stationed in Area No. III; two other doctors, Dr. GAMOFALO in Area I, and Dr. JACOVACCI in Area II are responsible for the diagnosis and therapeutic assistance to malaria cases in their respective zones, but Dr. COLUZZI is entirely responsible for the house-spraying programme.

The Rome Istituto di Malariology which has lent its personnel to assist in carrying out the programme, has a Centre in the same villa that houses the headquarters of the campaign and in which Dr. COLUZZI lives - at Casa delli Palme, near Monticelli in the Pontecorvo area. Next to the villa, which also contains a small laboratory and the office, are the warehouses, a small repair shop for the spray-pumps, and the motor vehicles are kept in the grounds.

1) House-Spraying Service

The spraying teams, each consisting of five well-trained men and a foreman, work directly under Dr. COLUZZI's orders and supervision, in any of the three areas. The number of teams varies between 6 and 9.

Six, out of the present eight foremen, were trained last year and took part in last year's campaign. The teams can treat the houses in any municipality; the resistance of the Trade Unions (which in Sardinia succeeded in having every single village treated only by workmen recruited in the village itself and appointed
by order of the waiting list) was overcome; with the advantage that all the sprayers are very well-trained and efficient. They live in villages in the vicinity of the campaign's headquarters.

DDT is sprayed only in the form of the 5% solution in kerosene. The solution is prepared as follows: every morning 8 kgms of powdered DDT are placed in each 50 gall. drum. The drums are then taken in a truck to the kerosene stores of the Italian Petroleum Company at Froscinone; here 160 kgms of kerosene are poured into each drum. The drums thus filled are transported back to the store and it appears that this drive of about 50 kms. in the sun is sufficient to promote the solution of the DDT.

Every worker has a particular pump allocated to him, for which he is responsible. He is provided with a standard spraying tube, 1.35 metre long. Synthetic rubber tubes, though far better than natural rubber, wear out after a few weeks.

The sprayers used are Hudson pumps, as in Sardinia, but unmodified. Italian-made sprayers (Galeazzi factory) are also used. They are much sturdier than the Hudson, all built of brass, but heavier; they cost 5000 to 7000 lira. The conical spray nozzle is preferred to the fan spray nozzle.

All premises are treated, even shops and stores, in accordance with the instructions of the High Commissariat for Hygiene and Public Health. Some stables in the treated areas have not been sprayed and they serve as controls. So far captures of mosquitoes in these control stables have been very meagre (we only found one or two specimens in the ones examined). I was told that more mosquitoes are to be found in the control stables of the Cefalò area where last year no house-spraying had been carried out. It would appear that in zones in which houses had been sprayed for the second year, the anopheles population has decreased. Data on larval density are being collected.

The spraying is done very carefully and one realises that the workers are skillful sprayers. Considering that the soil is well wet, as it should be, and that using the 5% solution, only 1.36 grammes per square meter are applied, one wonders whether in other areas a consumption of 2 grammes per square meter is not partly caused by wastage or by faulty spraying.

The present campaign began on March 10; on June 14, the programme was completed. House-spraying was nevertheless going on in localities where there was no autochthonous malaria, but where imported malaria cases had been notified or where it was esteemed useful to do spraying for main insect control.

2) **Diagnostic Service** (under the supervision of the Medical Officers of each area).

This service is a feature of the organization. Its
purpose is to ascertain microscopically all cases of malaria occurring in the province. Nurses, or public health nurses (21 in all) visit all fever cases, and collect blood specimens; these are either handed over by the nurses or sent by messengers on bicycle (three) to the nearest diagnostic centre. There are six of these centres, each provided with a microscopist and with the necessary material for blood examination. The provincial Public Health Laboratory in Frosonone also takes part in the service. Ascertained malaria cases are treated by nurses who hand the patient the amount of atebriin required for a standard treatment (adult dosage: 5 x 0.1 gramma tablets daily for three days; then 3 x 0.1 daily for three more days. Total atebriin grammes 2.4). Moreover, during the transmission season, patients showing crescents in their blood are given a course of plasmoquine or of certuna. During the pre-epidemic season known falciparum gamete carriers follow the same gametocide treatment as soon as the mean atmospheric temperature reaches 21 °C, that is, when the temperature would make possible the infection of mosquitoes from them.

Transport

The organization has:

- Heavy load truck, 3 tons ............ 2
- Light trucks, 0.7 ton ............. 2
- Touring car ...................... 1

FINANCING

The campaign is financed by the High Commissariat for Hygiene and Public Health, with a yearly budget, for the province of Frosonone, of some 24 million lire. Although the greatest part of motor transport was previously given by UNRRA, part of the 1946 budget has been invested in purchase of other trucks and motor cars, of furniture for the offices and nurses quarters, etc.

The salary of the worker — as well as of the foreman — is about 900 lire per working day: of these about 500 lire is the net salary cashed by the worker, the rest being absorbed for taxation and social insurance. Nurses (Assistenti sanitarie) and microscopists are given living quarters and are paid as follows:

- Nurses, about 20,000 lire monthly
- Microscopists, about 25,000 lire monthly

Before giving the data for 1947, it might be interesting to give those referring to previous campaigns carried out by UNRRA (Data in Dr. BENN's Report of the Health Division of UNRRA, Italian Mission, March 1947). In 1945 UNRRA treated by wall-spraying the Cassino area only, under the direction of an Engineer of the Sanitary Engineering Section. This work was done late in the season (16-26 September) but no further cases of malaria have
occurred since.

Man-hours employed ........................ 810  
Surface sprayed, Sq.m.iro .......... 103,863 
Surface sprayed per man-hour sq.m. ... 128  
DDT per sq.m. grammes 1.386  

Early in 1946, from February 15 to March 2, in agreement with the Commissioner for Malaria Control, UNRRA carried out house-spraying in some areas of the province in which the Provincial Antimalaria Committee could not efficiently carry out Paris greening for "technical, (danger of mines) or economic reasons, viz. in Cassino, Ceprano, Pontecorvo and Pico.  

Man-hours employed .......................... 4,520  
Surface treated, sq.m. ........................ 957,574  
Surface treated per man-hour sq.m. .... 211  
DDT per sq. m., grammes .................. 0.9707  
Inhabitants protected, approximately 25,000
another  

From June 10, to June 30/DDT house-spraying programme was carried out in accordance with instructions of the High Commissariat for Hygiene and Public Health, under the direction of Prof. RAFFAELE, with the assistance of Dr. COLUZZI. UNRRA supplied an additional amount of DDT for the purpose. The programme covered most of the malarious places of the province not treated in February, as follows:-  

Man-hours employed .......................... 9,600  
Surface treated, Sq.m. ..................... 798,980  
Surface treated per man-hour sq.m. .... 83  
DDT per sq.m. Gramme 1.59  

According to the 1947 programme the surface to be treated was of sq.m. 4,300,000; the premises to be sprayed were scattered over 28 municipalities; the population thus protected amounting to 138,687, the wall surface to be treated per inhabitant would be sq.m. 31.  

In 1946 a total of 11,255 blood examinations were performed in subjects of Area III, 5,150 were positive of which:  

Plasmodium vivax ............................ 5,462  
P. falciaparum .................................... 670  
Mixed infections .............................. 18  

The 1947 campaign began on March 10. From this date until June 15, i.e. in 77 working days, the following data were collected:  

Working days ................................. 77  
Man-hours total ................................ 26,680  
(these figures do not include the working time of the foremen or the mechanic)  
Man-hours actually devoted to spraying 19,823  
Surface treated, sq.m. ..................... 3,864,048
Surface treated per man-hour, sq.m. 195
Premises treated (rooms or stables, etc) 82,781
Daily average area sprayed per man-day sq.m. 1,286
Inhabitants protected per man-day: 1,286 : 31 = 41.4
DDT employed per sq. m. gramme 1.36

**TABLE**

Pre-epidemic spleen and parasite rates among school children, 6-14 years (Dr. Coluzzi).

<table>
<thead>
<tr>
<th>Locality</th>
<th>Spleen rates</th>
<th>Parasite rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1946</td>
<td>1947</td>
</tr>
<tr>
<td>Cassino III</td>
<td>81.2</td>
<td>32.2</td>
</tr>
<tr>
<td>Pontecorvo</td>
<td>73.3</td>
<td>57.1</td>
</tr>
<tr>
<td>Aquino</td>
<td>90.5</td>
<td>70.6</td>
</tr>
<tr>
<td>Sta Oliva</td>
<td>95</td>
<td>74.1</td>
</tr>
<tr>
<td>Monticelli</td>
<td>76.7</td>
<td>53.1</td>
</tr>
<tr>
<td>Esperia inf.</td>
<td>39</td>
<td>37.6</td>
</tr>
<tr>
<td>Esperia Badia</td>
<td>77</td>
<td>53.9</td>
</tr>
</tbody>
</table>

The interpretation of the fall in spleen and parasite rates after the 1945 campaign requires careful consideration. The years 1944 and 1945 were periods of high prevalence of malaria; most of the provinces having been practically malaria free before it may justifiably be stated that there was a proper epidemic of malaria. Now we all know that the worst possible time to test any measure of malaria control is the time of epidemic maximum or shortly afterwards especially when it has not been possible to keep accurate records of the prevalence of malaria during the epidemic, as was the case in this unhappy province. The decrease of the spleen - and particularly of the parasite rates in February 1947 is probably due in part to the interruption of transmission brought about by DDT, but also to a natural decrease of transmission following the wane of the epidemic, hastened by the use of Paris green during the summer of 1946. Data on the anopheline density in 1945 and following years as well as infant parasite rates and distribution of the various malaria species in the positive blood examinations should be very useful in assisting the malarialogist in the interpretation of the above table.

But no such data, of course could be collected in 1945; and the present organization, like UNRRA before it, was confronted with the very urgent problem of controlling malaria. Nevertheless when the report of the two years is published, there is no doubt that very valuable information will come to light.
THE DDT HOUSE-SPRAYING CAMPAIGN
IN THE PROVINCE OF LATINA
(18 June, 1947)

The province of Latina (formerly called Littoria) contains the Pontine area. It extends between Anzio and the Garigliano river and is bounded in the South by the Tyrhenian Sea, in the North-West by the province of Frosinone, in the North-West by the province of Rome and in the East by the province of Caserta. It is well-known that before the war, the Pontine Marshes had been reclaimed and transformed into a fertile plain, and to a large extent, malaria was brought under control. But this region became a battlefield from the autumn of 1943 to the summer of 1944. Pumping stations were destroyed or damaged, canals obstructed; the wire screening of the houses deteriorated and could not be repaired; medical assistance and malaria treatment became insufficient. In 1944, malaria attained epidemic proportions. In 1945, in Monte San Biagio, a town South of Terracina where prior to the war there was little malaria, four deaths occurred from pernicious malaria on June 10, an exceptionally early date for primary cases of P. falciparum infection.

ORGANISATION

(1) House-spraying service

The special Commissioner for Malaria Control is Prof. A. MISSIROLI, head of the Malaria Division of the Institute of Public Health (Istituto Superiore di Sanità) Rome. Dr. E. MOSNA, of the same Division, is in charge of the field service for this province.

The headquarters are at Latina, in a warehouse where the office, equipment, material and motor vehicles are gathered. There is also a small repair shop. The spraying teams consist of seven workers and a foreman. At the time of my visit there, seven teams were in function, one of which is stationed outside Latina in a town just being sprayed. The teams are under direct orders and supervision of Dr. MOSNA. The foremen are well-trained permanent employees; during the months in which they are not occupied in house-spraying, they still work for the organization, catching mosquitoes or larvae, doing office work, etc. Notwithstanding the objections raised by the trade unions, the men were permitted to work outside the boundaries of the municipality in which they were recruited, provided that the place of work was not too far away. Otherwise,

(*) see map
they were recruited on the spot, the foreman excepted (for example in Terracina, Fondi, Scutari, etc.). Most of the workers have had spraying practice since last year. This year, the 5% kerosene solution is still used practically all over the province; emulsion is employed only in a few areas.

The solution is made largely by hand; but difficulties arise when DDT, instead of being powdery as the Du Pont de Nemours product, has a tendency to cake. The Geigy DDT made in Switzerland can be powdered with a heavy roller, as is being done in the Frosinone programme, and sifted afterwards; but in Latina they also had a shipment of DDT made in Geigy’s factory in Italy, which is very sticky and has a great tendency to cake; apparently there was no other way but to disintegrate it by hand, without sifting it, to suspend it, always manipulating it by hand in a small quantity of kerosene, the suspension being then syphoned through plastic glass tubes into the rest of the necessary amount of kerosene in the iron drum. The drums are then rolled out of the shed, placed in the sun, kept there the whole day and then rolled in again at night. After three days of this process, the solution is ready for use. (This means two men working full time on the preparation of the solution, whereas the use of emulsion prepared with a concentrate of DDT does not involve this waste of labour nor the risk to the workers who, for hours on end, work with their hands in a kerosene solution of DDT).

Hudson spray pumps, similar to those used in Sardinia, are employed here without any alteration. Galeazzi pumps are also used with satisfactory results; they are heavier but they seem to stand up to rough usage better. There is a "Hudson peerless" power-sprayer in the warehouse; it has often been employed for spraying many-storied buildings, but Dr. MOSNA does not find that its use entails many advantages, while it has, of course, the disadvantage of requiring an operator to attend to the compressor, as well as a great length of heavy and costly synthetic rubber hose.

The nozzle preferred here (the same as in Frosinone) gives a conical whirling spray.

All houses, stables and out-buildings are sprayed; ceilings are always treated, even if the sprayers have to climb on chairs and tables to reach them with the three-metre-long shafts. Churches and stores, which are open only in day time and do not resent other insect problems, are excluded. The walls are sprayed from 1.50 metre upwards.

The campaign started on March 12; at the end of May all the region South of the New Appian Road had been sprayed and the operations were proceeding in the region North of the road.
(2) **Diagnostic service.** Such a service does not exist in this province, Prof. MISSIROLI considering it superfluous. Slides collected in out-patient clinics are examined in the provincial laboratory at Latina, and by a field microscopist at Fondi.

**FINANCING**

The 1947 budget for malaria control in the province amounted to 24,508,000 lire (Area of the Province: 2,427 sq. km.; population: 261,500; lire 93.70 per inhabitant). Trucks and cars had already been paid for; this budget does not include DDT, kerosene, or petrol for motor transport. The workers are paid 450 lire per day; the foremen receive the same salary, but sundays are also paid.

* * *

Before giving the data for 1947, we propose to summarize here those referring to the previous DDT campaigns carried out by UNRRA in this province (from Dr. BENN's Report of the Health Division of UNRRA, Italian Mission, March 1947).

In 1945, from June 6 to July 10, house-spraying was carried out by UNRRA engineers and locally recruited men, and financed by the High Commissariat for Hygiene and Public Health, in Fondi and Monte San Biagio. The 5% kerosene solution was used.

Man-hours, 1,609  
Surface treated, sq.m., 134,939  
Surface treated per man-hour, sq.m.: 84  
DDT per sq.m., gramme: 1.732

In 1946, UNRRA cooperated with the Special Commissioner for Malaria Control for the province of Latina, providing DDT concentrate, kerosene and transport. The technical direction of the work was entrusted to Dr. E. LÖSNA, assisted by Mr. PAVANELLO, UNRRA engineer. Emulsion was employed, for the first time in Italy, in the Latina area. Spraying started in March and came apparently to an end in May.

Man-hours: 47,047 *  
Surface treated, sq.m.: 7,656,619 *  
Surface treated per man-hour, sq.m.: 162 *  
DDT per sq.m., gramme: 1.75 *

* Figures revised by Dr. Mosna
The Provincial Anti-Malaria Committee continued the work in other places of the province, spraying for instance houses of the newly-reconstructed town of Latina.

In the Pontine area, a team succeeds in treating 12,000 to 14,000 sq.m. per day. Spraying began on March 10 and is still under way. During this year, 19 tons of DDT have been used up to date.

The amount of DDT used per sq.m. has varied as follows:

- March, grammes per sq.m.: 1.945 *
- April: 2.002 *
- May: 1.817 *
- June: 1.774 *

**Final data on the DDT anti-imago campaign in the Province of Latina**

(from March 3, 1947 to July 15, 1947)

Kindly communicated by Prof. MISSIROLI

<table>
<thead>
<tr>
<th></th>
<th>Unit</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% Solution</td>
<td>l.</td>
<td>400,575</td>
</tr>
<tr>
<td>Used 26% conc.</td>
<td>l.</td>
<td>9,742</td>
</tr>
<tr>
<td>50% miscible DDT powder</td>
<td>kg</td>
<td>1,061</td>
</tr>
<tr>
<td>Pure DDT</td>
<td>gr.</td>
<td>19,085,060</td>
</tr>
<tr>
<td>Surface sprayed</td>
<td>sq.m.</td>
<td>10,400,283</td>
</tr>
<tr>
<td>DDT per sq.m.</td>
<td>gr.</td>
<td>1,835</td>
</tr>
<tr>
<td>Houses</td>
<td>No.</td>
<td>20,345</td>
</tr>
<tr>
<td>Premises sprayed</td>
<td>No.</td>
<td>187,849</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>No.</td>
<td>57,544</td>
</tr>
<tr>
<td>Other rooms</td>
<td>No.</td>
<td>135,629</td>
</tr>
<tr>
<td>Stables</td>
<td>No.</td>
<td>11,269</td>
</tr>
<tr>
<td>Pigsties</td>
<td>No.</td>
<td>8,790</td>
</tr>
<tr>
<td>Hen houses</td>
<td>No.</td>
<td>6,813</td>
</tr>
<tr>
<td>Porches</td>
<td>No.</td>
<td>7,393</td>
</tr>
<tr>
<td>Isolated stables</td>
<td>No.</td>
<td>803</td>
</tr>
<tr>
<td>Huts and shacks</td>
<td>No.</td>
<td>10,461</td>
</tr>
</tbody>
</table>

* Figures revised by Dr. Mosna
Area sprayed ...... sq.m. 10,400,283
Workers employed:
Teams...... working days : 7,106   Hours : 49,742
Warehouse                          825                      9,775
Total                          8,031                      55,517
Area sprayed per man-hour: 209 (excluding workers employed
in the warehouse)
                           187 (including workers employed
in the warehouse)
DDT used in the Province of Latina: metric tons 19,085
DDT used in the Province of Caserta: 4,662
Area of the Province of Latina: 2,427 sq. km.
Population of the Province of Latina: 261,500

RESULTS

In 1945 (June) 50% of positive blood slides showed
P. falciparum. During that year, 6 million tablets of
atebrin were used in the province.

In 1946 there were no P. falciparum cases in the
areas sprayed in the spring, while in areas sprayed later
the falciparum morbidity curve was shifted to the autumn.
During that year, only an average of 20,000 tablets of
atebrin per month were used.

In Latina, the South-Eastern zone graphs showing
captures of mosquitoes give, for 1945, very high catches
in May (about 25,000 specimens); they reach a maximum in
June (about 33,000) and drop to about 4,000 in July. In
1946, DDT was sprayed in March-April and captures in May,
June and July gave fewer mosquitoes than during the hiberna-
tion season. The malaria morbidity curve in 1946
reached its peak in April, and from then onwards, it
steadily declined, instead of shooting up to reach the
summer morbidity maximum, as would normally have been the
case. In other words, only the relapses built up the peak
of the 1946 malaria morbidity curve. These results compare
with those obtained in Macaronesia as early as 1945, after
the zone had been sprayed between April 4 and June 15
(SOPER et al., 1947). Malaria mortality in 1946 was remark-
ably reduced in comparison with 1945 and the proportion of
P. falciparum infections in all the positive blood slides,
which had been extremely high in 1945, became very small
indeed in 1946. (All these conclusions are gathered from
Prof. NERI's graphs, not from tables).
Other graphs show the curve of general mortality before and after DDT house-spraying. In Terracina, Fondi and Formia, such graphs for 1945 and 1946 show:

1) a remarkable decrease of general mortality and a remarkable increase of natality in 1946 as compared with 1945.

2) while in 1945 the curve of the monthly mortality presents the two usual peaks, one in winter and the other in summer, in 1946, the summer peak disappeared. It seemed likely that this result was largely due to the decrease of deaths due to insect-borne diseases prevailing in summer. Malaria deaths would represent only a small proportion among them.

The reaction of the population is extremely favourable to the use of DDT; but there are rumours that in areas where DDT had already been utilized in 1946, and possibly even in 1945, this year’s house spraying seems less effective. In a village of huts, Selva Vetere near Fondi, now inhabited all the year round by people whose houses had been destroyed, DDT was sprayed in 1945, in 1946 and in the spring of this year. When we went there we saw no house-flies or mosquitoes in the huts, but some men approached us and very resentfully addressed Dr. Mosna, telling him that this year his sprayers must have put water in the DDT solution for at night the people were very much molested by mosquitoes and fleas. One of these men called his wife to show us numerous insect bites — probably flea bites — on her legs. The same man remarked that in 1945 and 1946 all insects, even fleas, had been entirely absent.

Of course, the psychological attitude of the population has changed. While formerly, in summer, they lived among hosts of flies, mosquitoes and vermin, they have now become extremely interested in insect control and both adults and children look out for any insect that might be found in the houses. It has also been suggested by some malaria workers that meteorological conditions this year might have created conditions more favourable for insect breeding. The spring was very wet, until May it rained a great deal in these regions, while 1946 was very dry. While we shall of course have to wait for data on captures of mosquitoes before supporting this suggested explanation, I cannot help thinking that in Greece the year 1946 was wet, while the spring of 1947 has been exceptionally dry (no rainfall since the end of February) and nevertheless there are also rumours among the population that this year’s spraying is much less effective than last year’s.