MALARIA CONTROL IN MOBILE WARFARE.
ITALIAN CAMPAIGN 1943-1945.

BY
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Fourteen hundred years ago Justinian's general, "the genial Belisarius," undertook a war in Italy which foreshadowed in astonishing detail the campaign of 1943-1945. From Sicily by Reggio and Salerno to Naples, from Naples to Rome, from Rome by "the rock of the Apennine" to Ancona and Rimini; step by step he forced the Germans (Goths) to their last shelter at Ravenna, and brought a four-year struggle to a triumphant conclusion in the same malaria-ridden plains which saw the final destruction of Kesselring's army.

Had this miniature edition of the recent campaign taken place in modern times its medical history might have afforded some interesting parallels. Unfortunately no such basis for comparison exists. The Italian campaign in the last war (1914-1918), for example, was fought under conditions so different that it would be idle to compare them. In any case, even if such comparisons were valid they would obscure the most interesting point about the battle against malaria in Italy, which is the fact that this campaign witnessed, not so much an improvement, as a revolution in the methods of combating malaria in war.

When the Eighth Army landed in Sicily its conception of malaria prophylaxis was not two steps ahead of the previous war. By the close of the campaign the control of malaria in mobile warfare had emerged as a practical proposition for the first time in military history. Given the necessary discipline and training, there is no reason why mobile operations in Europe should ever again be attended by heavy casualties from malaria.

Power sprayers; D.D.T.; aerosol bombs; an effective repellent—these, and the Jeep, have made it possible for an army to protect itself from malaria under the most difficult conditions. In studying the Italian campaign we can watch the effect of their introduction, first on the theory of malaria prevention, later and more tardily their results in the field. The evolution was never completed and malaria claimed its victims to the end, but they fell by tens where formerly they would have tumbled down in hundreds.

Sicily witnessed a medical disaster which repeated on a small scale many much-quoted episodes of previous wars, but which did not, fortunately, affect the outcome. The battle of the Lombardy Plain saw a new organization based on the new theory in full operation for the first time. The chief object of this paper is to trace the administrative steps which led from one to the other. To assess what was actually achieved is difficult, but it is significant.
that after the initial set-back in Sicily—an experience which those who were present never forgot—control measures were so effective that many medical officers are now unwilling to believe that any other region in Italy is really highly malarious.

**Malaria in Italy.**

In 1740, Horace Walpole mentioned "a horrid thing called the malar'ia, that comes to Rome every summer and kills one." It first "came to Rome" about 200 B.C., after the second Punic War, and throughout the ages a high prevalence in Italy has frequently been associated with the devastation of war. The sacking of Rome early in the fifth century A.D. and again in the sixteenth century were followed, for example, by severe exacerbations of malaria. Some evidence however, has been adduced (Celli) to show that apart from the influence of war on the one hand, and man's efforts at control on the other, waves of increase and decline extending over centuries at a time have occurred in Italy, the last of which began its "natural" decline about fifty years ago. It is not easy, therefore, to predict with confidence what the malarial condition of any part of Italy will be in a particular set of circumstances.

Hackett, in his celebrated work "Malaria in Europe," used two interesting maps to demonstrate the manner in which, the mortality from malaria in Italy declined in the forty-year period up to 1930. These show clearly that while the decline has been enormous, the distribution of the worst areas remains the same—namely (excluding Sardinia), the Foggia and Taranto plains and the southern half of Sicily. In other words, a glance at the malaria map must have suggested when the Italian campaign was planned that the invaders were about to be thrown into contact with the worst of whatever malarial risks the country might be able to offer.

How bad it was likely to be nobody could have predicted with certainty. In 1887 the malaria mortality in Italy was 710 per million; by 1914 it had fallen to 57. During the last war it rose year by year to a peak of 324 in 1918, but by 1939 it had been reduced to the low level of 14 per million. From 1924 onwards the reduction had been partially, and perhaps largely, due to land reclamation schemes carried out under the direction of the Rockefeller Experimental Station in Rome. It soon became clear that the systematic destruction of these bonification schemes was part of the policy of the German Army in retreat, but to what extent this would result in an increase in malaria was a problem to which there could be no definite answer.

Long after the Allies had established themselves in Italy, and access had been gained to the best Italian sources of information, the same uncertainty existed regarding the parts of Italy as yet unoccupied. At the end of June, 1944, one malarialogist was rash enough to circulate a "Review of the Malaria Situation in Italy," based upon data obtained from certain reputable authorities. This had no sooner appeared than it was fallen upon by the malarialogists of another unit, who declared themselves, at considerable length and not without heat, to be "at variance with most of his points." They insisted that neither the past history of malaria in Italy, nor malaria morbidity figures, nor spleen nor parasite rates, could be accepted as indices
of the state of any district in Italy under the peculiar conditions of warfare; the habits of the vector were liable to change, intensive medication of the population in malarious areas made spleen and parasite surveys unreliable, and a fluid refugee population reduced prediction based on pre-existing conditions to absurdity.

**Planning for Sicily.**

At the close of the Sicilian campaign the lessons of the operation were reviewed. The reports make interesting reading. It was easy then, and it is easier now, to discover faults, when the critic is unhampered by the practical administrative difficulties of a large combined operation, the forces and staffs of which were dispersed over three widely separated Commands.

The original instructions were excellent; reliance was to be placed in the initial stages on mepâcrine, protective cream (Mark II), clothing precautions, and head-nets for assault troops. Later, "as soon as possible after landing," nets or sandfly-proof bivouacs were to be provided and flysol spraying was to be carried out. It is only when one studies the results that the loopholes in the original plan become obvious; which is not the same thing as saying that they could have been avoided. For example, it was soon evident that most troops who went into action wearing shorts would not, and often could not, change into slacks after sundown, and it was realized that it would have been better not to have issued shorts at all. Yet it was eighteen months, and the third season in Italy, before repeated medical representations resulted in a temporary and grudging withdrawal of shorts from troops in a highly malarious zone of operations.

Sicily was the Eighth Army's first contact with malaria and, even if the training and equipment had been beyond criticism, casualties would certainly have been suffered through inexperience. As it was, later investigation showed that too much of the training had been theoretical. The D.D.H., Middle East (Colonel A. E. Richmond, C.B.E.), after a visit to Sicily when the epidemic was at its height, commented that "practical training (in the use of individual protective measures) had not been adequate—this as distinct from theoretical instruction, of which much had been given. It is felt that one and a half hours at least per week should be included in the training programme of all units likely to proceed to malarious areas. This instruction should include the actual putting up of bush-nets and bivouacs, the application of cream, important points in the selection of camp sites, etc."

The 1st Canadian Division prepared for the operation in England and Scotland. They were particularly unfortunate in regard to malaria training. Certain vital instructions about precautions and planning were either lost in transit from Cairo or very much delayed, and no clear direction was received until the D.D.M.S., 30 Corps, visited the division in the U.K. only five weeks before the date of the actual landing in Sicily. A specially trained malaria officer, who was provided by Middle East and flown home, was so much delayed en route that he only joined the division three days before embarkation. It is hardly surprising that the A.D.M.S., 1st Cdn. Div., commented rather bitterly: "Planning for protection against malaria offered many problems mostly caused by lack of clear information of the conditions to be
met and inexperience with the disease in general. In this one thing alone, one feels that concise, comprehensive instructions should be made available to English-planning staffs, at once. Information trickled in slowly and seemed incomplete. Time for planning was brief and there was no time for extensive training of special personnel. Equipment was provided so late that no one had time to see it, let alone become familiar with it.” He mentions, also, that “for reasons of security medical officers were not allowed to commence the study and discussion of malaria and other tropical diseases until too late on in the planning.”

The inadequacies of training showed themselves in many ways, all of which contributed to the casualty figures. The irregular taking of mepacrine and lack of supervision in regard to it, carelessness over clothing (individuals in shorts, or even without shirts after sundown, and officers wearing cut sleeves, were common sights in the early stages), failure to use protective cream, lack of understanding of the purpose of head-nets, bad camp site selection—all are mentioned again and again in the reports.

As so much reliance had been placed on mepacrine it was unfortunate that the administrative arrangements should not have been perfect. Formations complained, with some justification, of a lack of uniformity in regard to the prescribed regime, and a verbal loophole in an Army Instruction appears to have led to a widespread impression that mepacrine was only to be taken for a period of five weeks.

The most obvious error in regard to equipment was the fact that mosquito-nets were not a personal issue. Several different types were provided (bush-nets, sandfly curtains, bivouacs for two men) and they were held on charge by units and were supposed to arrive with the unit transport. In many instances they were very much delayed—one unit had arranged for the nets to arrive on “D plus 20” transport, and one brigade was still without nets a month after landing. It is hardly surprising to find that these particular units had very heavy casualties.

Another mistake which probably had an unfortunate indirect influence on the whole of the subsequent campaign was that the old Mark I cream was issued to 13 Corps instead of the much more acceptable and more efficient Mark II cream which had been authorized. This was the origin of a prejudice against repellents of any and every kind, which lingered until the end of the war. Men who had been in Sicily swore that “anti-mosquito cream” actually attracted mosquitoes.

Failure to ensure that malaria control units and the malaria field laboratory got their transport across at an early stage greatly restricted their usefulness. A month after the landing the O.C., Malaria Field Laboratory, who was also Adviser in Malaria to Headquarters, Eighth Army, was still without a car for his personal use. The effect on the efficiency of the laboratory was reflected in some acid criticisms by one A.D.M.S. who complained that malaria survey reports were received so late that they had only a “nuisance value.” If there was any justification in this criticism at the time, there was certainly none thereafter. Once the field laboratories were provided with the independence and mobility they asked for they constantly operated so far forward that accurate reports were often available within twenty-four hours of the capture.
of a new area, and on many occasions they carried out their surveys under fire.

The Anti-Malaria Control Units for the Sicily operation were thrown together in haphazard fashion; being "A" units with a medical role they were nobody’s baby, and nothing about them was satisfactory. They were formed too late or not formed at all; the personnel were unsatisfactory; they were untrained or wrongly trained; one A.M.C.U. lost itself in Tunisia and never reached Sicily; others arrived without officers, without transport, without equipment. When they did at last get to work their operations were unco-ordinated because the parent formations were constantly on the move and had no clear idea how to employ them. It was soon realized that the only way to use them effectively was to place them under central control at Army, a solution which raised what someone described as "screams of parochial dismay," and a compromise had to be accepted; one of the two Units with each division came under Army control, the other remained with its formation.

The second season in Italy was far advanced before an effective system for employing A.M.C.U.s under mobile conditions had been worked out, and—a much more difficult proposition—put into operation despite the parochial feelings of the diehards. Many difficulties would have been avoided if malaria control units had been mobilized in the first instance as medical units on an Army and District basis.

SICILY AND AFTER, 1943.

What happened in Sicily may be briefly described.

D-Day was July 10. During the first fortnight there were about 200 cases of malaria due to infection elsewhere. About July 23, the Sicilian mosquitoes began to take their toll and cases poured into the medical units in alarming and increasing numbers. In the first week in August there were 1,302 malaria admissions, in the second there were 1,819; this latter was the peak. By September 3, when the invasion of the Italian mainland began, the Sicilian campaign had produced 7,138 cases of malaria and 3,257 “N.Y.D. Fevers”—a possible total of 10,395 casualties due to malaria. From August 1 to September 3 the malaria wastage was 0·88 per 1,000 per diem; if “N.Y.D. Fever” is included the daily wastage becomes 1·24 per 1,000.

The heaviest toll was from 5 Div. and, 50 (Northumberland) Div., who were infected in the highly malarious Lentini–Catania Plains. To quote the A.D.M.S., 50 (Northumberland) Div.:

“For three and a half weeks, during the battle of Primosole Bridge and in the plain south of Catania, the Division was deployed on a two Brigade front, with the third Brigade close up in reserve. These Brigades and supporting arms were in the centre of a ‘red’ (highly malarious) area on the malaria map. They were overlooked by the enemy; and movement had to be mainly confined to the hours of darkness. The fighting conditions were hard, the ground littered with dead bodies and enemy refuse, the troops were widely scattered and before the final withdrawal of the enemy . . . the troops engaged in these battles began to show definite signs of fatigue.” This Division had 1,217 cases of malaria; five of its Infantry battalions sustained 433 casualties from malaria between them.
The severity of the outbreak caused surprise and anxiety amongst the staffs at all levels, and unit commanders admitted freely that they had never fully realized the danger, despite the instructions and warnings which had been given. The D.D.H., Middle East, recorded that he had been told that "junior officers and senior N.C.O.s set a particularly bad example as regards individual measures of protection. It was also very clear that formation staffs were not blameless. . . . It was credibly reported that one area commander was notorious for his disregard of personal anti-malaria precautions."

It is unnecessary to describe the measures which were taken once the danger was realized, as these have been sufficiently indicated in the criticisms mentioned above.

Sicily left a legacy which contributed very largely to the malaria incidence during the first three weeks on the Italian mainland. Between September 4 and November 27 a total of 15,547 cases of malaria and fevers N.Y.D. was admitted to medical units in the Eighth Army, and of these at least 8,000 were due to infection in Sicily. Four weeks after the landing at Reggio there was a dramatic fall in the number of malaria admissions from 1,477 in one week to 523 in the next (week ending October 2) and thereafter the incidence gradually declined. On the whole the danger was less acute than in Sicily, the season was farther advanced, and the malaria discipline was rapidly improving.

To preserve a just perspective, it should be realized that the malaria casualties in the Sicilian campaign were small compared with those suffered by British forces on many occasions in the last war. The average incidence in Sicily during the worst six weeks of active operations (July 23 to September 3) was equivalent to 275 per 1,000 per annum. This seems high; but in Macedonia in 1918 the incidence for the whole year was almost 460 per 1,000 (59,087 cases) for the entire force.

Sicily was the Jutland Battle of the struggle against malaria in the Italian campaign. Our casualties were severe, amounting almost to a defeat in themselves, but they did not affect the outcome; and thenceforward there was never a time when malaria caused any serious operational embarrassment.

**New Weapons and a Fresh Orientation.**

At the close of his account of malaria in Macedonia in the Official Medical History of the last war, Colonel C. M. Wenyon made the following observation:—

"It would seem that a properly carried out campaign of protection against the mosquito would have reduced the incidence of malaria more than the unavoidably imperfect and partial anti-larval work carried out in Macedonia."

The fact that in mobile warfare, in particular, adult mosquito destruction is the best method of supplementing personal protective measures was realized long before any practical means existed for putting the idea into effect. The 13 Corps medical plan for the assault on the Italian mainland laid special emphasis on the importance of spraying out "all tents and all rooms of all buildings within 3 kilometres" of each unit, using flysol and flit guns. The
idea was good but difficult to put into practice, one reason being that at that
time—and indeed for long afterwards—too much emphasis was always placed
during training upon anti-larval measures.

At the end of March, 1944, details of a number of developments which
appeared to make possible destruction of adult mosquitoes on a large scale
were first received in Italy:

(a) Power sprayers.
(c) Insecticidal “sparklets,” each weighing about an ounce, intended as
an individual issue to forward troops.

Small quantities of D.D.T. arrived in April and, in the same month, the
first consignment of power sprayers was issued to the Eighth Army. The
sparklets failed to materialize and a supply of Westinghouse Aerosol Bombs
was asked for instead; but it was over a year before either of these items
became available in any quantity, and they were never employed by British
troops during active operations in Italy.

Experiments with D.D.T. as a residual spray in buildings confirmed the
claims which had been made for it, and it was quickly realized that a new
phase had opened in the battle against malaria in the field. It was estimated
that rooms treated in the prescribed manner, using 5 per cent D.D.T. in
kerosene, would remain lethal for about two months to mosquitoes which
rested in them. It should be possible, therefore, to achieve a high degree of
control over newly occupied areas in the minimum of time and, in combination
with the usual personal protective measures, this method offered, for the first
time in military history, the possibility of really effective malaria control in
forward areas.

Solutions of D.D.T. are dangerous if carelessly handled, and personnel who
mixed and applied them had to be specially trained; the obvious answer was
to confine the use of D.D.T. to A.M.C.U.s and to co-ordinate their activities
so that all areas were treated systematically, with due regard to the distribution
of troops and the results of surveys by the malariologists.

The credit for working out an effective organization on these lines in the
Eighth Army is due to Lieut.-Colonel J. Morgan, O.B.E., I.M.S., who was
A.D.H., Eighth Army, until his death in August, 1944. The recommendation
that all Malaria Control Units should be put under the command of Army H.Q.
was made in the early days in Sicily, but the welding into an effective weapon
of this conglomeration of ill-found, badly trained and often recalcitrant units
was a formidable task. Amongst them were many individuals who were
keen and reliable, but on the whole the conditions under which these units
had been formed had made them the repository of the misfits and throw-outs
of every arm of the Service. As late as July, 1944, we find the following re­
marks in a letter by Lieut.-Colonel Morgan about the D.D.T. spraying scheme,
in which the A.M.C.U.s used Italian Labour who could not be closely
supervised to spray out farms:

“...The officers and men are so poor in type that we have to keep ringing the
changes constantly. They must be better personnel than we get as they have
to work independently. They have gifts and vino thrust upon them on all
sides and their round frequently degenerates into a bibulous, hiccupping procession in which the B.O.R. is carried along by the Italian labour.”

Eventually, however, every difficulty was overcome, and it was found that when properly supervised these units did excellent work and showed an unexpected keenness. The power sprayers initially supplied proved to be unsuitable for D.D.T. spraying as they could not be adjusted to give a satisfactory wetting spray and tended to overheat with prolonged running. They were therefore switched over to flysol spraying and knapsack sprayers were used instead for the application of D.D.T. The method of operation under active conditions was briefly as follows:

(a) One A.M.C.U. formed a Malaria Control Depot, located near Army H.Q. This depot prepared and issued the D.D.T. solution and supplied labour and materials of every description, rations, mail, pay, orders, survey reports, etc., to all A.M.C.U.s by means of a despatch service which visited each A.M.C.U. every second day. This made the A.M.C.U.s independent of the moves of local formations.

(b) One A.M.C.U. was organized as a Forward Spraying Unit. Flysol power-spraying teams, each consisting of a driver and two operators equipped with a power sprayer mounted on a vehicle (a Jeep for preference), were allocated on a divisional basis and covered the entire front. They operated from Field Hygiene Sections and sprayed all habitations on the axis of advance. In 1944 there were 14 teams under Army control; in 1945 there were 24. A sanitary assistant of the Field Hygiene Section supervised their work locally, but the A.M.C.U. officer was charged with the duty of co-ordinating their activities and maintaining close liaison with divisional staffs.

(c) D.D.T.-spraying A.M.C.U.s were distributed across the front on a basis of two per division. They followed up the work of the flysol-spraying teams, covering an area extending to 3 kilometres on either side of the axis. They were placed under the immediate supervision of two officers from the malaria field laboratories, who visited them frequently, checked the results of their work and (to ensure flexibility under rapidly changing conditions) moved them as necessary without prior reference to Army H.Q. Each house as it was completed was marked with the letters “D.D.T.”, the number of the A.M.C.U. and the date.

This scheme worked admirably. In April, 1945, the A.M.C.U. system was replaced by a Malaria Control Company on a new establishment, but the method of operation remained essentially the same. It had the enormous advantage over the original system of divisional A.M.C.U.s (in which each Unit could be employed only in the area of its parent formation) that it was an easy matter to concentrate the total potential on the parts of the Army area which most required control. Polish and New Zealand A.M.C.U.s were not included in the scheme, with the result that they frequently expended energy and materials in non-malarious areas.

It was a pity that the Westinghouse Aerosol Bomb and the Insecticidal Sparklet did not become available until the greatest need for them was past. Unit mosquito squads were supposed to carry out twice-daily spraying within unit lines, using hand guns and anti-mosquito spray, but it is doubtful if this was ever done in an effective manner. The Aerosol Bomb is so simple to
operate, and so much more likely to be used, that it seems the complete answer to the problem of inducing unit squads in forward areas to concentrate on adult destruction.

Air larviciding was first employed in Sicily in the Lentini area; later it was used in many parts of Italy, including the Pontine Marshes, Cassino, Lake Trasimene, and the canal systems near Perugia and Arezzo; but these operations were insignificant compared with the programme for the Lombardy Plain offensive in 1945. This included the use of both paris green and D.D.T. Planning was based on an empirical figure of 30,000 acres which might require treatment, half with paris green and half with D.D.T. A storage and loading depot was established on Rimini airfield, which included three large tanks with a total capacity of 9,000 gallons connected by a pipeline to a feed pipe near the runway. The D.D.T. solution was mixed by hand in 44-gallon drums, pumped into two small (300-gallon) tanks where solution was completed, and run by gravity into the storage tanks. Paris green and diluent (powdered cement) were mixed in a machine constructed for the purpose by a technician in a soup-powder factory at Cesena, put up in stout half-hundredweight paper bags and loaded into the aircraft by hand. This depot was capable of dealing with 10,000 gallons of 5 per cent D.D.T. solution and 20 tons of 25 per cent paris green weekly. (The strength of the paris green mixture was later reduced to 15 per cent as a result of ground checks.) The aircraft were Bostons and Stearmans, flown by American pilots under the direction of a malarologist (Major H. G. Aitken, U.S. Sanitary Corps) in collaboration with the O.C., 8 Malaria Field Laboratory (Lieut.-Colonel D. N. Keys). The pilots were extremely keen and the organization worked without

![Image of mixing and storage tanks for D.D.T. solution. Rimini Airfield, 1945.](http://militaryhealth.bmj.com/)
Fig. 2.—D.D.T. solution piped to runway and pumped into aircraft. (Note small Venturi spraying tube.)

Fig. 3.—Hand-loading Boston with 15 per cent paris green. (Half-hundredweight paper bags. Note Venturi tube.)
A. W. S. Thompson

a hitch. In the first five weeks of the season they laid down about 30 tons of paris green mixture and 50,000 gallons of D.D.T. solution.

The keenness and ability of the pilots were so great that one hesitates to make any comment on air larviciding which might be construed as a criticism of their skill. Treatment by means of aircraft is so spectacular, however, and so simple to lay on, that as a weapon against malaria it is liable to be misapplied. The number of areas really suitable for air treatment is limited, and great care in selecting sites and frequent ground checks are necessary if it is to be employed to full advantage. The following is quoted from a report by the present writer:

"The distance from Rimini airfield to Nonfalcone or Palmanova is about 130 miles as the Boston flies, and the weather conditions on the area to be treated may be quite different from those on the airfield when the pilot takes off, particularly in this part of Italy which is notable for its localized rainstorms. On the morning of June 18, the A.D.H., Eighth Army, happened to be at Palmanova when a Boston came over and attempted to treat the moat with D.D.T. in oil. There was a strong east wind, the moat twists between high steep ramparts, and on the side of the town which the pilot was attacking there are many wires which make low flying dangerous. The plane roared low down over the ramparts at about two hundred miles an hour spewing a yellow cloud of oil on the wind, wheeled away, circled, roared down again, and so on in a series of spectacular dashes which must have thrilled the onlookers; but to one of them it was a most depressing sight. On this occasion at least the pilot risked his life in a gallant but almost completely unsuccessful attempt to do what might have been done with perfect ease and accuracy from the ground. Enquiry elicited that the O.C., Mal. Fd. Lab., did not consider the moat at Palmanova suitable for air treatment, but had been assured that the pilot was satisfied that he could do it."

Before leaving the subject of aircraft, the importance to the malariologist of reconnaissance from the air should be mentioned. A light aircraft (the Fairchild is very suitable) should always be available in malarious country, and would be particularly valuable if fitted for the paris green dustings of small inaccessible areas.

Training and Propaganda.

A vast amount of training was carried out during the campaign at the C.M.F. School of Hygiene, at Field Hygiene Sections and Malaria Field Laboratories, by pathologists in mobile bacteriological laboratories and hospitals, and by regimental medical officers.

In the early days formal training showed the usual tendency to lag behind development in the field. This was particularly noticeable in the case of A.M.C.U. personnel. To quote Lieut.-Colonel J. Morgan, O.B.E., I.M.S. (May, 1944):

"In training A.M.C.U. personnel less stress must be laid on physical measures of control. To be stressed should be the urgency of establishing initial control by adult destruction and chemical larvicide application. These things must be carried out with all speed on entering a zone. And the first of these is always adult destruction. A typical programme of an A.M.C.U.
as at present trained is—1st day: choosing a site and getting another unit to which it can attach itself; 2nd day: dipping for larvae and looking for adults; 3rd day: establishing liaison with formation and surrounding A.M.C.U.s, etc. They must be taught that their job is immediate control. With only one or two exceptions the A.M.C.U.s might to all intents and purposes be a collection of quite untrained personnel. In fact, it might have been better had they been so.”

Individual training was on the whole very successful. The standard of personal prophylaxis bore testimony to this. The one measure which teaching universally and completely failed to put over was the use of repellent. To the end of the campaign the prejudice against repellents remained unshaken; it amounted, indeed, to more than mere prejudice; it was a complete lack of appreciation, a rooted and scornful distrust. The average soldier simply did not believe in the necessity for a repellent or that the stuff he was given was of any value, and the majority of officers might have been unaware of its existence. There was something wanting, some fundamental error, in the whole of our teaching about this particular precaution; but one cannot help feeling that there may have been factors involved to which the psychiatrist might have been able to supply the clue.

A great deal of propaganda was devoted to mepacrine, and in the second and third seasons it was obvious that the vast majority of troops were mepacrine-minded and took their daily tablet, regularly. In some respects propaganda showed too strong a bias towards suppressive treatment, producing an impression that this was the most important aspect of malaria prophylaxis. By the third season mepacrine was so firmly established in popular favour that not only formation staffs, but a proportion of the rank and file, wanted to commence it sooner and continue it longer than the dates given by higher authority.

Pure propaganda about malaria, as distinct from teaching, may be directed towards one or both of two objects:—

(a) Generally impressing on the soldier the necessity for taking precautions.

(b) Commending to his favour particular devices or courses of action, e.g. the Flit gun, care of the mosquito-net, the wearing of slacks in the evening.

The first is infinitely easier than the second, and the sign “This is a Malarious Area” was probably as effective in this regard as the most elaborate poster. In general, it may be said that propaganda of the first type was well done and generally effective; of the second it was poor. Many of the official posters were ugly and undistinguished, comparing very badly with, say, beer propaganda in civil life, and most of those produced by field hygiene sections showed more enthusiasm than inspiration or artistic ability. There were notable exceptions: the excellent official productions by Hopper, for example, and the wall paintings, well placed and brilliantly executed, carried out in the forward areas by a certain Pte. Goodale of 2nd Cdn. Fd. Hyg. Sec. in 1944. Honourable mention is also due, perhaps, to the famous life-sized poster at Anzio of “Jane” (surely the least malaria-minded of wartime personalities!) which had to be removed because it stopped the traffic.

Health weeks were organized by A.F.H.Q. in the second and third seasons, in which education officers of all formations collaborated with the Medical
Services and malaria was given special attention. The first, in 1944, was extremely successful. The second came just after the close of hostilities and was handicapped by the prevailing feelings of reaction. In the Eighth Army two Hygiene Exhibitions were held which evoked an astonishing amount of interest from the troops. The 1945 exhibition was open for six days and was seen by about five or six thousand every day, many of whom waited cheerfully in queues for nearly an hour to get into the model tents. The malaria exhibits attracted a degree of interest which caused surprise, as there had been a feeling that the troops were "getting browned off" with incessant malaria propaganda. This was patently not the case. To the end of the campaign it was constantly found that teaching about malaria, if properly presented, was well received.

**Episode at Monte San Baigio.**

At the end of July, 1944, an incident occurred which demonstrated in startling fashion the danger of relaxing malaria vigilance in Italy. It was an object lesson so striking that it produced a salutary effect on anti-malaria discipline generally, and may possibly have conferred more benefits in the long run than the injuries it inflicted at the time.

The 56 (London) Division disembarked at Taranto on July 17 after a short spell in Middle East. Between July 21 and July 28 they moved to Tivoli.

At the end of the first week in August their malaria figures rocketed; from a level of 30 to 40 cases per week they shot up to 344 cases in the second week in August, followed by 119 the next week, and dropping back to 44 cases the week after. The peak was on August 9, when 64 cases were admitted, and the incidence for that week was equivalent to 984 per 1,000 per annum.

The source of the outbreak was not difficult to trace. An advance party of 1,000 which detrained at Itri produced no cases of malaria. The remainder of the division were to have gone by train as far as Palestrina, north of Rome, but, at the last moment, the insecurity of a tunnel caused Movement Control to alter this, and the division left the train at Monte S. Baigio in the marshy district north-east of Tarracina, in one of the most celebrated haunts of malaria in Europe. They remained at the station for upwards of three hours before leaving in M.T. for Tivoli.

The journey from Taranto took about forty hours. The trains were very crowded, with up to 40 men and their personal kit in box trucks. It was impossible to use mosquito-nets. The journey was very slow, with many halts, and in the final portion, through the marshes, swarms of mosquitoes invaded the train and men were bitten both by day and by night. At the station itself there was an obvious mosquito nuisance.

About half of the division detrained at night. As each train arrived "medical instructions emphasizing the highly malarious nature of the area and detailing full malaria precautions were handed to the O.C. and M.O." Their grateful comments are not recorded.

After full investigation the Consulting Malariaologist (Brigadier G. Macdonald) was satisfied that the outbreak could not be attributed to a medical breakdown. Mepacrine was commenced on June 21, and "full precautions" were ordered for the journey from Taranto; these comprised...
daily mepacrine, clothing precautions, and the use of repellent. Mark II cream (pyrethrum type) had been issued in Middle East. Failure could be traced, as usual, not to any fault in the arrangements, but to the manner in which they were carried out.

With two exceptions units which arrived at Monte S. Baigio by night had more cases than those which arrived by day. These exceptions are interesting:

167 Field Ambulance.—This unit had only one case in the second week in August. "Mepacrine and repellent supervision were of the highest order. At each stop during the night officers and N.C.O.s carried out an inspection of clothing and satisfied themselves that repellent was being used."

100 Lt. A.A. Regt.—This unit (strength 1,100) had only 9 cases in the week in question—i.e. about half the incidence in that week for the whole division. "At Taranto all three batteries were given a talk on malaria precautions by the M.O. To ensure that all men attended the lecture other duties were held up by the O.C. The O.C. also held a conference of all battery and troop commanders in which the importance of anti-malaria precautions was emphasized. . . . Nevertheless, though clothing was supervised on the journey, mepacrine and repellent were not."

Throughout the division generally, however, investigation showed that precautions had been lax. Mepacrine had not been properly supervised, and with the single exception mentioned above the use of repellent had not been enforced; indeed, in some units it was not even issued to the men until they arrived at Tivoli. The Consulting Malariologist made the following comments:

"Under intense anophelism such as was encountered it (i.e. Mark II cream) might be 100 per cent effective for a short period only, one to two hours. There may have been difficulties in application under the very crowded conditions, and great heat may have caused sweating that tended to wash it off. Despite these drawbacks, which might have limited its value, I consider that regular use by all ranks throughout the journey would have prevented an outbreak of this size."

The crux of the matter was, of course, that Movement Control had taken it upon themselves to alter the detraining station to a place which would not have been selected by anyone who understood the realities of the malaria situation. Nevertheless, even without this alteration cases would still have been caused by mosquitoes entering the train as it pulled slowly through the marshes, especially at dusk or at dawn. The same conviction arose in the minds of everyone who read the story of the outbreak: any division in Italy at that time might have fared as badly, and the standard of prophylaxis generally must be tightened up.

The Plains of Lombardy, 1945.

When the Anzio beach-head at last burst open at the end of May, 1944, the malariologists sighed with relief, and switched their attention to that north-eastern corner of Italy where malaria has been rife since time immemorial.

In July a letter was circulated to all medical officers in the Eighth Army,
informing them that "Professor Missiroli, the eminent Italian malariologist, had expressed the opinion that the Ravenna plain was now probably more malarious than the Pontine Marshes." A second letter issued to all formations two days before the assault on the Gothic Line (August 25) contained the following warning:

"Almost the entire valley of the River Po is malarious. . . . Under war conditions the risk will undoubtedly be greatly augmented by several factors, amongst them deliberate flooding. It is probable that this will be carried out by the enemy with the advice of competent malariologists with the intention of increasing malaria as well as mechanically obstructing troops, as has already occurred elsewhere in Italy. Until precise information is gained by survey after occupation it should be assumed that the whole valley north of the Rimini-Bologna road is extremely malarious, with a risk equal to or greater than that encountered in Sicily, in the Lentini plain, in 1943."

The advance was less rapid than was expected. Ravenna was not captured until the beginning of December, and the season was over before any considerable number of troops had entered the danger zone. The malaria organization had been granted a breathing space.

The interval was not wasted. General propaganda and training were purposely withheld until the spring, in order to get the maximum response from an intensive drive at a time when the danger was less remote, but courses for junior medical officers and malaria staff officers were held during the winter, the training of unit squads commenced in February, and malaria control personnel were given a refresher course lasting for two weeks in March. The Italian combat groups which came under command received special attention, as they presented both an immediate problem in sanitation and a threat for the future, on account of the enormous number of gametocyte carriers amongst them.

Nearer acquaintance with the Lombardy Plain did nothing to allay the anxiety of the malariologists. In the area already occupied there was a considerable amount of flooding, and air photographs showed a great deal more ahead; and it would be an easy matter for the enemy to put vast areas under water by blowing the dykes farther up the Po Valley. The experts made gloomy prognostications about the possibility, if this happened, of the rapid spreading westwards of *A. sacharovi* (*elutus*) from the saline marshes near the sea.

The propensity of *elutus* to bite by day was used as a weapon of medical diplomacy to such effect that when the 1945 season opened the Army Commander ruled that shorts would not be worn in the Eighth Army except for organized recreation. Quite apart from the improvement in individual protection which this order conferred, it had the advantage of impressing on the minds of all ranks the fact that there was an unusual malaria risk that season. It was gratifying to overhear references in the Mess to the ferocious mosquito of the Po Valley.

Transmission was not expected to commence until early in May and active breeding was unlikely before the middle of the month. The arrangements for spraying and aircraft control have already been described. D.D.T. spraying was started on March 18, working first along the main routes in the worst areas, with the object of destroying as many hibernators as possible.
Flysol spraying was to commence on May 1, with a total of 24 teams, the personnel of which were used prior to that date to augment the D.D.T. programme. This, as it turned out, was a mistake; it would have been better to employ both methods from the beginning, when the greater rapidity of flysol spraying would have achieved a wider slaughter of hibernating mosquitoes. When the big offensive began the flysol teams were got on the road as quickly as possible and all were functioning before the end of April. Aircraft larviciding commenced on May 15, although little evidence of breeding was found before the end of the month.

The Eighth Army flung itself into its last battle on April 9, and in twenty-three days the campaign in Italy was over. The speed of the advance made it utterly impossible for the spraying teams to keep pace with the forward troops, but they did their best, and the main routes were covered long before large-scale transmission could have commenced. Four British detachments, each equivalent to two Malaria Control Units, were employed on D.D.T. spraying, in addition to the Polish and New Zealand units which worked independently. It was found that one detachment using Knapsack and Pressure (Four Oaks Kent type) sprayers and employing about 100 labourers could spray about sixty farms daily. Over a thousand gallons of D.D.T. solution were used in the Army area every day.

Immediately hostilities ceased it became possible to arrange for most units to be sited outside the more dangerous regions and concentrate the spraying organization on the parts of the "red" area which were still occupied. When, towards the end of May, the D.D.T. programme was completed, all detachments were switched to larval control. The combined attack on these danger spots by D.D.T. spraying and larval control from the air and on the ground was so successful that in the extremely dangerous coastal sector near the mouth of the Isonzo, for example, where for political reasons certain elements of 13 Corps had to remain, the mosquito population virtually disappeared and the malaria rate remained consistently low.

The final battle of the campaign was over before the malaria season was properly started, although elutus in its uneasy hibernation in farms and outhouses claimed some victims. The extra-regimental spraying organization was put to the test of a mobile battle, the ability of the soldier to protect himself was not. When full precautions were instituted it was found that the standard was generally very high, but it must be acknowledged that in the third season in Italy no troops were ever exposed to anything comparable to Sicily in 1943. The malaria risks were probably not as great; the difficulties certainly bore no comparison.

**Summing Up.**

The tragedy of preventive medicine is, that its failures are obvious; success can never be proved. Failure has been given prominence in this account, because by such acknowledgments we learn; but those who took part in the campaign and were competent to judge must have realized how much was achieved. To demonstrate it mathematically is another matter. We know what the casualties were; we do not know what they might have been.

Let us glance at the figures.
If we consider the whole Force, we recall that at the outset of the campaign the incidence in one particular week rose to about 410 per 1,000 per annum. In 1944 there were two weekly peaks in Italy, one in May, 150·62 (w.e. May 6) and one in August, 146·21 (w.e. August 12). In 1945, up to the end of June, the highest rate in any week was equivalent to 38·85 per 1,000 per annum.

In 1944 the incidence was over 100 per 1,000 per annum in eight weeks during the first half of the year, and four weeks in the second. In only four weeks during the first half of 1945 did the incidence rise to more than one-third of this figure.

Secondly, if we compare the incidence of fresh cases of malaria in the Eighth Army with battle casualties, we find that the ratio falls progressively from two to one at the beginning of the campaign to less than one in ten at the end:

<table>
<thead>
<tr>
<th>Year</th>
<th>Quarter</th>
<th>Malaria (Primary)</th>
<th>Battle Casualties (Wounded)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1943</td>
<td>3rd Quarter</td>
<td>12,532</td>
<td>6,415</td>
<td>2 : 1</td>
</tr>
<tr>
<td></td>
<td>4th Quarter</td>
<td>4,178</td>
<td>8,637</td>
<td>1 : 2·1</td>
</tr>
<tr>
<td>1944</td>
<td>1st Quarter</td>
<td>901</td>
<td>3,500</td>
<td>1 : 3·9</td>
</tr>
<tr>
<td></td>
<td>2nd Quarter</td>
<td>3,037</td>
<td>15,516</td>
<td>1 : 5·1</td>
</tr>
<tr>
<td></td>
<td>3rd Quarter</td>
<td>3,288</td>
<td>19,975</td>
<td>1 : 6·1</td>
</tr>
<tr>
<td></td>
<td>4th Quarter</td>
<td>927</td>
<td>10,995</td>
<td>1 : 11·9</td>
</tr>
<tr>
<td>1945</td>
<td>1st Quarter</td>
<td>365</td>
<td>3,679</td>
<td>1 : 10·1</td>
</tr>
<tr>
<td></td>
<td>2nd Quarter</td>
<td>600</td>
<td>6,210</td>
<td>1 : 10·4</td>
</tr>
</tbody>
</table>

Finally, as a rough test of the efficiency of protective measures under field conditions at the end of the campaign, we may compare two similar formations of equal size, one in a non-malarious country (Austria) and one in an area which is in part very highly malarious (Venezia Giulia). From May 5 to June 23 the 5 Corps were in Austria and 13 Corps were exposed to malaria in Venezia Giulia; yet their malaria figures were practically identical:

<table>
<thead>
<tr>
<th>Corps</th>
<th>Malaria &quot;Fresh&quot;</th>
<th>Malaria Relapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>111</td>
<td>122</td>
</tr>
<tr>
<td>Venezia Giulia</td>
<td>121</td>
<td>113</td>
</tr>
</tbody>
</table>

Total 233 234

In the middle of the period in question 5 Corps had discontinued mepacrine and the majority of their "fresh" cases were due to a break-through of previous infection. This comparison indicates that a formation can be kept in a malarious zone in June without any increase in its malaria incidence over what it would have shown in a non-malarious country. (The average weekly rate in this case was 0·44 per 1,000 per week.)

It has not been possible in this brief sketch to pay tribute to the many hundreds of workers throughout Italy whose efforts contributed so largely to the wellbeing of their comrades, and only passing mention has been made of the most important factor of all.
The control of malaria in war can never be perfect without the informed and intelligent co-operation of the individual soldier. The most elaborate schemes cannot protect him if he will not protect himself. Discipline alone is not enough. What matters is his response when he is not under supervision; not the disciplined observance of rules, but action based on knowledge and understanding and a sense of personal responsibility.

What we are trying to protect, and the most important material we have to work with, are the same; not a Force, or an Army, or "The Troops"—but MEN and it is only by considering them as men that we can hope to conquer malaria in the field.

For the foe is not just an organism or an insect. It is wily Nature herself, in all her complexity.

"If you would see all of Nature gathered up at one point, in her loveliness, and her skill, and her deadliness, and her sex, where could you find a more exquisite symbol than the mosquito?"