**PROGRAMME OF CLINICS AND SPECIAL DEPARTMENTS**

**AT KINGSTON, ST. VINCENT**

<table>
<thead>
<tr>
<th>Day</th>
<th>Clinic</th>
<th>Time</th>
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<tr>
<td>Monday</td>
<td>Dental V. D. (Males)</td>
<td>8.30 to 10.30 a.m.</td>
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<td>Tuesday</td>
<td>Child Welfare</td>
<td>8.30 to 10.30 a.m.</td>
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<td>Wednesday</td>
<td>Radiological</td>
<td>10 a.m. to noon</td>
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<td>Thursday</td>
<td>Dental V. D. (Females)</td>
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<td>Friday</td>
<td>Child Welfare</td>
<td>8.30 to 10.30 a.m.</td>
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<td>V. D. (Males)</td>
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<tr>
<td>Saturday</td>
<td>Radiological</td>
<td>10 a.m. to noon</td>
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Notes: The Dental Clinic is under the charge of the honorary Dental Surgeon, appointed for the time being. It is intended primarily for school children, and will be extended as funds permit.

The Child Welfare Clinic will eventually be in charge of a specially trained Nurse, (one is under training at present), and she will help also to organise similar Clinics in the Districts. At present it is being operated by the Matron. It is held at the Child Welfare Centre.

The V. D. Clinic will be under the charge of the Resident Surgeon while the Matron is responsible for providing the necessary nursing staff in attendance at the Clinic for females. It is held at the V. D. Centre.

These Clinics are intended to help poor persons and advice and / or treatment is free of charge.

The opening of the Radiological Clinic will have to await the return of the specially trained Medical Officer, which has been delayed. There will be no charge for poor persons, but persons classed as paying patients will be charged in accordance with an approved scale.

There is also a Bacteriological Laboratory. This is under the direct control of the Senior Medical Officer and specimens for examination and report can be received daily.

The Simmons Ward, built under the Simmons Bequest, provides first class ward accommodation, superior to that in the Graham Wing, and, in the absence of nominated patients, may (under certain conditions) be occupied by other persons.

31st August, 1937.

(A. G. H. Smart)  
Senior Medical Officer,
SCIENTIFIC PUBLICATIONS
BY A.G.H. SMART.

(a) An Uncommon Fracture of the Radius - Journal of Tropical Medicine, 1912.


(c) Impressions of a Health Week in Malaya - Malayan Medical Journal, June 1931.

(d) Some Health Aspects of Housing in Malaya - Jour. Institute of Architects of Malaya, October and November 1932.

(e) Synopsis of the Commoner Malayan Snakes with special reference to the Venomous Snakes - Malayan Medical Journal, December 1932 and March 1933.

(f) The State Control of Leprosy - Malayan Medical Journal, December 1933.
A STUDY OF MALARIA

AND ITS PREVENTION,

UNDER CERTAIN CONDITIONS,

WITH SPECIAL REFERENCE TO MALAYA.

BY

A. G. H. SMART.

1919
Every year Malaya spends large sums on the treatment and prevention of malaria, which is reckoned as easily the main cause of wastage in these Territories. The amount spent in Selangor on prevention alone in 1933 which was a typical year is shown in the appendix to these notes and the special allocation of funds is indicated. Selangor is one of the most important States in the Federation and the amount spent was close on £17,000, whereas considerably less than this amount served for the complete Budget of the Medical Department in the Colony in the British West Indies in which the writer served recently. To get the amount spent annually in the Malay Peninsula this figure must be multiplied many times.

The diagnosis of malaria is far from being complete in Malaya because still only a comparatively small proportion of cases enter hospital and only a small proportion of cases is seen post mortem. In 1937 the total of deaths in the Federated Malay States from malaria which were diagnosed come to 1,144, whereas the total group classification of malaria and fevers of undefined type accounted for 14,174 deaths or 36.3 per cent of the total.

While malaria is largely absent within controlled, which is synonymous with, urban areas it is known to be a most important cause of wastage and death in rural areas, even after discounting to a large extent the value of undiagnosed returns of deaths. To a great
extent this knowledge is derived from, and is confirmed by, other sources of information such as the results of school inspections, mass spleen surveys and attendances at infant welfare centres.

Moreover in Malaya there has in recent years been a trend towards an actual increase in the amount of malaria noted in rural districts and increasing attention is being directed towards this aspect of the public health. It is perhaps, therefore, not out of place to draw attention to some of these sources of infection, and towards the more recent aspects of preventive work in such circumstances and under conditions that do not entirely conform to the usually accepted and employed methods of control, more especially those which relate specially to urban areas.

Of course there is no sharp boundary between the methods necessary to deal with malaria or potential malaria under different conditions and reference is made not so much to any new class of work but rather only to modification of recognised methods designed to suit unusual circumstances as these arise. Dealing with the subject in this manner there must necessarily be a certain amount of overlapping.

Neither is it proposed to deal in any detailed way with adjuvant means of treatment by such drugs as plasmoquin, atebrin and quinine; and discussion will mainly be confined to those problems of which the writer has had practical experience in Malaya. Such conditions
may for convenience be grouped under the following headings which include most of the factors that influence the choice of method in dealing with malaria under these conditions;

(A) a position when there is definite lack of funds.
(B) in cases where protection is required only for a limited period i.e. while certain work is in progress.
(C) where the terrain or physical nature of the country makes some modification necessary or possible.
(D) where modification is needed for what might be termed 'aesthetic' reasons, or to avoid damage to crops.
(E) where it is essential to preserve the subsoil water for domestic or agricultural purposes.
(F) where a special class of population has to be catered for.

Lack of funds has been placed first because it is a consideration of vital importance. Malaya spends and has spent in the past large sums on mosquito control, and the prosperity of the country in past years has allowed such work to proceed almost as demanded by the responsible authorities. But the critical financial situation of recent times has caused searching enquiry into methods and indeed into every avenue where reduction of expenditure is possible. Perhaps the Federated Malay States felt the rigours of the economic blast more than any other part of the country and the demand for economy was incessant and compelling. Prosperity is now returning to the country and conditions are fortunately reverting to normal.
First brief reference will be made to a modification of existing methods of oiling which has been employed in Kuala Lumpur by the Health Officer whereby total working costs have been reduced by 30% and oil expenditure by over 50%. Kuala Lumpur Sanitary Board area with a perimeter half a mile in width covers an area of 30 square miles. This is controlled by some 220 miles of buried drain laid down and maintained by the Public Works Department but the routine antimosquito work that is employed now is practically all of a temporary nature using the term in contradistinction to the term permanent as applied to subsoil draining, with permanent surface drains.

The method employed by him is a modification of one suggested earlier by Dr. W.T. Quaife and it differs from the latter in the following respects:

(a) Only mops are used in the latter while the sprayer is the chief medium of application in Kuala Lumpur; (b) the Kuala Lumpur method covers all types of breeding place which can be encountered in an area such as Kuala Lumpur and can be used from the commencement of operations in a new area. Quaife advocated a heavy spraying campaign in the first instance for a year or two and noted the inapplicability of his method in areas of widely distributed seepage; (c) the Kuala Lumpur method results in an average minimum length of drain of 26 chains being oiled to the gallon. Quaife indicated "10 or more chains according to the width of the drains to be treated".
(d) the Kuala Lumpur method employs a tried anti-malarial mixture. Quaife employs a much cheaper oil, namely Diesel Fuel.

The actual procedure, which is worth describing in detail, is as follows; it has now been employed by the Health Officer successfully for some years. The modifications introduced have made the method applicable to such country as that in and around Kuala Lumpur from the very commencement. By the brush-spray technique a reduction in expenditure on oil of at least 50 per cent without any reduction in area or safety, over all periods of the year, has been demonstrated. Such experience indicates that there is little doubt that methods of oiling in general use are unnecessary, expensive and wasteful. Efficiency in supervision is, of course, essential under such schemes but any small increase in expenditure under this head can only be considered to be a definite economy measure in view of the permanent and general saving shown to be possible.

The following apparatus is used:- Sprayers of the 'Four Oaks' type; brushes, strongly made and with firm bristles; oil buckets; hand-carts with 30 to 40 gallon drums attached to each; mops of cocoanut fibre attached to handles.

The following routine procedure is followed:-
(a) Collecting gangs. The whole of the controlled area is divided into two separate sections. Four collectors under one inspector cover each section once every fortnight
and report on the exact conditions of the drains to be oiled, any new or special breeding places requiring attention and the effects of oiling.

(b) Maintenance gangs. On the day prior to oiling, each area is visited by the maintenance gang under an overseer and put into proper order.

(c) Oiling gangs. Each gang consists of an oiling overseer and three coolies. Oil is brought to a convenient place on a hand-cart, and a sprayer and two buckets are filled, the spraying coolie carrying his sprayer and the hand-cart coolie the two buckets which are used to fill the sprayer as required. When these are empty, this coolie returns to the hand-cart and brings it to the next most convenient spot before joining his comrades with further full buckets.

In the meantime the rest of the gang choose the drain, stream, etc. to oil, starting about a hundred yards from the "discharge end". A thin line of oil sprayed on the surface for four paces and the "brush coolie" then vigorously distributes it for a hundred yards or more according to the width of the drain. The coolie brushes rapidly with the flow of water, taking care that all side pockets and small channels are effectively dealt with.

He then joins his comrade and they proceed up stream to the next oiling point, a further hundred yards or so. When the brush coolie has reached the original point of application he doubles back again to his waiting comrade. As the "spray" coolie proceeds he deals with any seepage or side channels he comes across and, before each area is left, all further seepages in it are sprayed, all large
ponds similarly treated at the edges and all small ponds and pot-holes and such like places treated by the mop dipped in oil.

It must, of course, be realised that constant, skilled and intimate supervision is essential under such a scheme where oil application is reduced to a minimum.

A reduction in the collecting gang from eight to four has been possible but there has been no further reduction in staff.

Complete and detailed observations over a twelve months period have shown that although the present oiling methods are far cheaper than those previously in use their merits have been proved to be equal to any by the results obtained.

With this method it should be emphasized that, although it is apparent to experienced workers that much oil is constantly wasted whatever method of oiling is employed, it must always be remembered as regards actual oiling that one is usually dealing with persons having little or no education largely of the coolie class and that any suggestion of discrimination as regards oiling in dealing with a dangerous area is practically impossible.

The overseer through the Health Inspector has to be given quite definite instructions and left with no powers of choice or discrimination, or harm will result. In other words it is better to risk and incur waste of oil rather than risk and incur the spread of malaria by failing to issue instructions and draft a plan that is largely fool-proof.
The actual oil employed is the standard antimalarial mixture which has been used for many years. Recently trials of a slightly different mixture have been made, the modification consisting mainly in substituting the kerosene element by a light "solar" oil of very similar properties. Careful experiments have been carried out with this oil with varying results. The experiments are still going on.

This factor, lack of funds, applies also in a large measure where schemes in rural areas come under review and there is also the fact to be taken into consideration that supervision of any such scheme cannot be maintained from a distance of many miles. Thus it is important that antimalarial control in villages should be of such a nature that it can be carried out, and to a large extent controlled, by the peasants themselves.

As an example showing how this may be possible a method of subsoil draining that was suggested in 1932 may be referred to. The Health Officer reported to the Malaria Advisory Board in that year that his method had been practised at Kuala Lipis for some eighteen months.

The description of the method is as follows:-

The pipes are made from the Bamboo, Dendrocalamus flagillifer. The stem is cut on either side of the nodes, giving pieces 9"-1 ft. in length, with an internal diameter of 2" or better 3" and the wood ½" or more thick. The pipes are then soaked in water for ten days in order

* Dr.E.A. Struthers, Malayan Medical Service.
to remove the internal pith coating, and after drying in the sun are ready for laying. The pipes in two ravines were also treated with tar.

The gradient in the ravines treated is about 1 in 70. Before subsoiling all trees and bushes in the ravine, likely to obstruct the pipes are removed. Hill foot earth drains are dug so that, when laid, the pipes will be at least 4 feet deep and these are kept open for about a week, in order to see that they are effective. In large ravines a central drain may be necessary. Once the earth drains are found to be working satisfactorily, the bamboo pipes are laid end to end in the drains. The junctions between the pipes are surrounded by clay to prevent as far as possible the entrance of silt into the pipes. The position of the pipes is indicated on the surface by bamboo pegs.

Inspection pits are put in at all junctions between pipe lines, and at least one in each length of pipe line. They are made of ordinary tile pipes set vertically end to end and the bamboo pipe at the bottom of the inspection chamber is cut in half to form an open invert. The top of the inspection chamber is closed by a wooden plug with a direction arrow cut on the upper surface. Inspection pits, also serve to diminish the pressure in the pipes by acting as storage chambers for excess storm water.

It is not necessary in every case completely to subsoil the ravine and once beyond the seepage area the pipe lines can be brought to a common exit in an open
earth drain. In order to prevent erosion of the earth drain, inverts made of sheet iron are laid along the drain. The inverts can be made from empty iron tar barrels, which are cut vertically into two sections. They are laid in the earth drain so as to overlap, in the direction of flow, by about three inches, and are secured to the sides of the drain by means of wooden pegs.

The cost of upkeep is exclusive of expense entailed by relaying as blockage has only occurred in the ravines treated originally where the pipes were not laid sufficiently deep. The causes of blockage are similar to those in any system of subsoil drainage a contributing cause being the size in diameter of the pipes used.

The method of subsoiling is a comparatively cheap one; upkeep involves the use of less labour than ordinary temporary work and supervision is easier. It is of limited application but is, however, a method worthy of consideration in the case of isolated Government lines such as those of the Public Works Department and Railways, and remote Police Stations situated in unhealthy areas. It is practically impossible to protect such places efficiently by oiling owing to the difficulty of supervision and high cost of transport of oil. Bamboos are often available on the spot and, once subsoiled, it is easy for a Health Officer to inspect the ravines in the course of his journeys through the district.
Another *Health Officer has reported on similar experiments carried out at Lenggong and Grik in Perak. The work was commenced in July 1932 and was apparently based on the work previously done in Pahang.

Similar work has been done more recently in Selangor, with some modification of the original methods. The costs here worked out at $1.50 per chain for the bamboos and $8 per chain for the earth work. Bamboos should last about two years and cost approximately 8 cents for a 15 foot length.

The work carried out by B.A.R. Gater and R.B. Wallace in Kedah on seasonal variation in the incidence of breeding will, no doubt, when some definiteness has been attained, result in economy of oiling or other methods of treatment in the future, especially where it is possible to carry out adjuvant treatment through the agency of drugs. But meantime no risks can be taken in the vicinity of larger towns where recognised methods must be assiduously maintained. There have been instances in Selangor where in spite of constant and strict supervision small outbreaks of malaria have resulted from the temporary breakdown of control owing to some cause that could not be foreseen and guarded against.

Now to turn to (B) where protection is required only for the period when certain work is being carried out and where labour will not be permanently resident at the site. Many instances of this nature have occurred in

* Dr. E.B.D. Wolfe, Malayan Medical Service.

X Straits dollar = 2/4d.
Malaya and can be quoted. Often they are associated with the provision of water supplies where the Head works are usually in some area far removed from any large residential area and where no permanent population is left behind. Another instance is where an approach road is being constructed to some hill site, as for example the approach roads to Fraser's Hill and Cameron Highlands and that contemplated to Penang Hill.

As an illustration of the first type the conditions at the Head works for the Alor Star water supply may be quoted: this town is the capital of Kedah. The work was commenced in May 1913 when knowledge of mosquito control was not so advanced as it is now, and the site was some 20 miles distant from Alor Star and was not easily supervised. The scheme involved the tapping of two streams and conducting these into two large tanks each of 400,000 gallons capacity, and constant interference with these streams was occurring. Health was good until November of that year but by the middle of December about half the labour force of 300 persons was down with malaria. The period of good health was coincident with a fairly heavy monthly rainfall but after December there was a period of drought when only a total of 2.6 inches of rain was registered within three months. This with the continual interference of the streams rendered necessary by the operations going on, together with, incidentally, the occurrence of cholera among the labour force, created a difficult situation that was only finally relieved by the
advent of normal rains and the ultimate dispersal of the labour force. This was an instance, recorded nearly 25 years ago where A. maculatus was driven to breed in sites not usually associated with this species. For example this mosquito was found breeding in pools formed by leakages from a pipe line leading to the coolies' quarters highly contaminated with organic refuse. A full account of this outbreak was published in 1914.

This has been quoted in order to draw attention to what it is possible to be up against in such cases. The procedure nowadays, with the extensive knowledge derived from experience of the past, is to anticipate the occurrence of such an outbreak by dealing in the most complete manner with any possible breeding places but, in addition to such precautions, the most careful supervision and co-operation is needed during such operations to avoid the occurrence of malaria, which originates usually as a direct consequence of interference with, and disturbance of, the natural terrain and underground channels of drainage.

As an excellent example of modern procedure the work at Gunong Pulai in 1923 and 1924 under the control of the Municipal Health Officer of Singapore may be cited. This is fully described by Dr. Hunter in a report to the President of the Singapore Municipality. In his account Hunter mentions one of the chances that one is up against despite all possible precautions that are taken, to which allusion has already been made. During the course of the work
at Gunong Pulai a contractor with a labour force of 73 men had, unknown to Hunter, been sent to live in an old temporary line outside the protected area and it was found on a visit by him that 30 out of this total were lying sick in the lines. A high percentage of films made from these coolies showed the presence of malaria parasites.

Where a small permanent staff is left behind, as often happens, adequate protection is in most cases ensured by the automatic cessation of interference with water channels, by any necessary ditching and by planting shade growth over potential breeding areas and, finally, by ensuring that no parasite carriers are allowed within the area. This latter can be readily insisted on in the case of Government labour and the procedure is regularly carried out in the Federated Malay States.

Another instance referred to under this heading is that where an access road has to be constructed to some hill site. The conditions met with are not identical with those catered for in the previous examples, for in this case protection is required for a population that is continually on the move. As soon as one section of the road is completed the labour force is moved on and that area can be left to return to a more natural state. A good illustration of this class of work is that of the construction road to Cameron Highlands starting in the year 1925 and continuing for five years thereafter.

A short history of the scheme will make the position clear. In 1888 provision was made for a cart road
from Tapah to the Pahang Pass which it was suggested would reach the high level country described by William Cameron in 1885, and Sir Hugh Low in the same year suggested that this high country might be a suitable site for a sanatorium. In 1889 provision was made for the completion of the first twelve miles of the cart road from Tapah but the work was abandoned after only eight miles of the road had been completed.

In 1903 work was recommenced and the road completed up to the 12th mile from Tapah and considerable earth work done beyond that. In 1922 various officers visited the Cameron Highlands and reported and, as a result, a meteorological observation station was set up. In 1925 the Chief Health Officer visited the Highlands and commented on the probability of malaria occurring along the route of the proposed road, which probability was indeed quite obvious to the experienced observer.

No data are available regarding the health of the labour force during construction of the first twelve miles of road from Tapah but it was said to have been bad and it can be assumed with some certainty that this was the case.

A regular staff was employed from the first on antimalarial work and this staff was increased as extension of the work demanded. Supervision was exercised from Tapah at the first mile by the Health Officer stationed there.
It may be said at once that A. maculatus was recoverable throughout the whole course of the road trace which extended over 36 miles up to the Highlands. Access was provided for a long time by mule paths which allowed for observation of the road track in advance. The only other species of anopheline that was at all plentiful was A. aitkeni - a common jungle species. The quantity of A. maculatus at any given time varied with the construction work going on at the time and was almost entirely associated with such work. It was very obvious from various circumstances that only some small break in the chain of protection would be sufficient to light up an outbreak of malaria but at no time was any site out of control in this respect.

The magnitude of the task involved can be gauged by studying the road mileage under control at any given time. The work commenced late in 1925 with two miles of road and attained a peak early in 1929 when at one time, for a few months, 27 miles of road were under control. This involved an expenditure of 500 - 600 gallons of oil weekly using on an average one gallon to each four chains, and the employment of eight gangs, or a total of 50 coolies and overseers, with an allotment of 3½ miles of road to each gang. This peak figure dropped quickly to seventeen and nine miles in 1930 when the road was completed. It should be remembered that this oil, for the most part, had to be carried by hand; in a typical year (1929) the expenditure for oil and oiling amounted to *$23,000. In

* Straits dollar = 2/4d.
the same year, which is quoted as the most representative year of all, the labour force averaged 2,300 persons, three fifths of whom were Chinese and about two fifths Indians with about 150 Malays and others. There was an average of thirty admissions to hospital monthly of which about eight per month were because of malaria, with a total of two deaths on this account throughout the year. The highest death rate in that year was on account of beri-beri of which 16 cases were seen and six deaths were recorded.

As there was a barrier at the fifteenth mile through which all traffic had to pass it is reasonably certain that cases of sickness were sent to hospital and it is quite certain that no deaths occurred in the lines of which the Health Officer was not informed. Sick in the lines varied from ten a day (in September) to 17 a day (in January) and averaged throughout the year thirteen per diem. The total deaths in 1929 amounted to 28 which gives a rate per mille of 12.2 compared with the death rate for the Federated Malay States in 1929 of 24.6. The total deaths for the last nine months in 1928 (reliable figures of deaths are not available before that date) were 36 out of an average population of 2,600. Six of these deaths were due to malaria and six to beri-beri and the average daily sick totalled 20 persons. The average population in 1927, when control was not so efficient, was 700 and twenty coolies per month were admitted to hospital.
These figures give a clear idea of the state of health on this construction work during these years and show that at no time after control was in force was there an undue amount of sickness. On the contrary, even allowing for a few deaths which escaped notice, the health was amazingly good in view of all the circumstances and in view of what one knows might have happened if control had not been efficient.

It seems unnecessary to describe in detail the actual measures of control that were adopted. They did not constitute a novelty for Malaya and have become almost stereotyped for application in such circumstances. But as they may not constitute a routine practice everywhere a brief description may be of some value.

The measures, which were undertaken with the willing co-operation of the Public Works Department and the contractor's Manager, included the examination of all labour passed for employment. This was carried out by the resident dresser stationed at the 15th mile and, although a number of persons managed to evade such examination by approaching the hill through paths away from the main road, examination was in the main carried out pretty completely. Further, no persons other than those slightly sick were allowed to remain in the coolie lines but were transferred to hospital at once.

As regards antimalarial work as such the Health Officer in every case made careful surveys (usually in advance) of camp sites and all possible breeding places,
as these were found, were noted, numbered, and charted on a spot map. Regular larval surveys were of course made and fresh breeding places were at once noted and included under the local scheme. Small streams and drains were defined as far as possible and seepage areas connected up with existing drainage. In spite of the most careful supervision breeding places would escape notice from time to time and minor outbreaks of malaria would result, sometimes as a result of cutting down bamboo or jungle timber and removing shade, although every effort was made to control this. Wherever possible a piped water supply was laid on to each camp. This prevented coolies interfering with the natural subsoil drainage by digging earth wells and creating breeding places for A. maculatus. As a camp site was abandoned it was allowed to revert to jungle.

Cases returning from hospital were kept under observation and quininization employed on these cases. No other antimalarial drugs were employed. The visiting dressers had each a roster of lines to visit and each line had its own book showing the "health state" which was kept there and which could be seen by the Health Officer or the Manager at their respective visits. The employment of mosquito nets was made compulsory and in the case of Chinese labour no effort was necessary to ensure that mosquito nets were regularly used.

The efficacy and efficiency of such measures depended very largely on the degree of supervision.
exercised by those responsible and it may be said here that the good results that were obtained were almost entirely due to the untiring energy and care which the Health Officer in charge devoted to his task.

Another good example of such work is that relating to the protection from malaria of those engaged in preparing the site for, and the construction of, the Naval Base at Singapore. The writer himself was engaged in antimalarial work on part of this site a number of years ago and is familiar with, and can appreciate, the problem that confronted those responsible for the health of the large staff working at the Base. This work, which was entirely successful, has been described by Given who was in charge and by O'Flynn, who dealt particularly with treatment and with prophylaxis. This, of course, is an example where antimalarial measures carried out during construction would remain as permanent work for the protection of the establishment to be retained at the Base.

Perhaps it may be added that, in Malaya where experience covers so many aspects of antimalarial work, and the lessons of neglect in taking proper precaution are so readily available to those who enquire, it should be recognised, as a matter of routine, that neglect to take such precautions in advance amounts to neglect of duty. The public are apt to regard any achievement of this nature as something extraordinary. This should not be so and the public should rather be educated to realize
that protection *can* be afforded under such conditions and that the health authorities, with the wide experience available, are competent to ensure that no disturbance of the public health will follow construction work of this nature.

The third classification is (C) where the terrain or physical nature of the country makes some modification of existing methods necessary.

The instance at Bukit Wong is an example of this also. The valley there had a rocky channel of quartzite formation with steep hill slopes covered with jungle coming down on either side. This is typical of much of the country that has to be dealt with and the problem often demands much ingenuity.

The brush mop method of oiling, rather than the employment of drip feeds, as a rule deals satisfactorily with such sites because the different parts are thoroughly impregnated with oil and its influence is extended. Any toxic soluble bodies in the mixture are completely incorporated with the water and must often act early by poisoning larvae. But modifications of method are often needed.

Small areas of seepage can usually be localized and defined and led off to the nearest part of the stream, and places where irregularity in rock formation hold up seepage water can be dealt with by cement filling. A typical instance of this nature is the hill stream below
the Post Office on Penang Hill, where extensive and thoroughly effective antimalarial work has been carried out in conjunction with work in the Settlement itself.

Sometimes A. maculatus is found breeding on the sea beach among the rocks in which fresh water seepage is present. One instance noted in Penang island was in a partial cave where the sun penetrated for only a few hours daily; another typical instance was found at Port Dickson but such breeding places may be found anywhere and they must be dealt with as the occasion demands.

Seepage often occurs from the face of rock being worked at in quarries and these areas of seepage may vary from day to day. These are often very dangerous areas and if breeding cannot be controlled it may be necessary to close the quarry. One difficulty is that quarried stone to be used for building purposes cannot be saturated with oil or it loses its capacity to knit with cement and the best procedure to adopt is often to collect such seepage at the lowest point by making a reservoir and treating this with petrol.

In dealing with any anopheline breeding place one first essential is to secure if possible good drainage and in a country like Malaya it is often found that the natural channels of drainage are obstructed. This may be caused, and often is, by silting of the rivers as a consequence of mining operations in the upper reaches of such water, although the Government has endeavoured to control or at least minimise this evil by clauses in
mining leases and by special legislation prohibiting the discharge of effluent containing more than a certain proportion of suspended solids. The Government again employ river dredges to try and maintain proper channels in the main rivers.

Nevertheless there still is a large amount of silting occurring in Malayan rivers and this reacts on the areas drained by such rivers and raises the level of subsoil water in contingent areas and thus increases, through backward pressure, sources of seepage. A typical example of this was seen at Batu Gajah recently and A. barbirostris was found infected. This was recovered from the swamp that had formed as a result of the silting of the Kinta river. In the higher areas A. maculatus was recoverable and seepage was increased on account of the lack of exit for subsoil water. The net result was that Batu Gajah suffered from periodical outbreaks of malaria.

A situation like that probably demands a combination of measures these being deepening of, and defining, the channel of the river, filling in of the swampy areas largely by such dredgings and, finally, the elimination of A. maculatus breeding areas by subsoil drainage. But the important thing to be kept in mind is that first of all before attempting anything else the natural channels of drainage must be released and restored. A full account of this outbreak has been published.
Although this is largely a matter for the engineers it is referred to specially because similar conditions are so often found. If this fundamental rule were kept in mind in the case of rubber plantations many areas of so-called swamp would be at once eliminated. As however each estate has largely to depend on the co-operation of its neighbours difficulty often arises, because of blockage on an adjacent property.

Much good has resulted from the canalizing of the Klang river near and in Kuala Lumpur during the last few years. This was undertaken primarily to prevent flooding in the town but has also made malaria control a much simpler problem. Similar work has been carried out in the neighbourhood of Ipoh.

With regard to estates it may be found that antimalarial work to cover a set of lines may involve so much expense owing to the nature of the immediately surrounding country that it may be actually cheaper in the end to move the lines to another site.

In one instance of this nature where only semi-permanent lines were involved on a rubber estate on a small island off Singapore the suggestion was made that fresh lines should be built on the shore actually over the sea, with the result that malaria among the labourers became a thing of the past.

There is again the type of place where the main antimalarial drains from certain ravines discharge into the sea as at Lumut in the Dindings. In this case water
gates have to be provided to prevent the tidal invasion of the sea into the ravines. These should, if possible and if a good type is obtainable, be self-acting as this to a great extent eliminates the human element. But even in this case constant supervision is essential as a small twig or other debris may block the gate and keep it constantly open.

In such areas the migration of land crabs may cause a lot of trouble. It was found necessary at Lumut in one instance, to save destruction or interference with the drainage system, to sink iron plates vertically for a depth of some feet on either side of the main drain near the sea. Paris Green has been tried as a remedy for this but no really satisfactory or effective method of controlling invasion by land crabs, whether by chemicals or by some such agency as already mentioned, is known.

Another instance indicating how methods of control must get at the actual source of trouble is illustrated by an outbreak of malaria which occurred at the Quarantine Camp, Port Swettenham, in 1931. This was traced to mosquitoes (A.sundaicus) coming from two sources - one at an aerodrome site under construction and the other where squatters were felling mangrove jungle in the vicinity. The latter site being much closer to the camp was probably the main source of trouble. Although A.sundaicus could be recovered readily from this site at the time it was not found after the jungle was allowed to grow up again.
Outbreaks due to A. sundaicus occur from time to time as a result of erosion of bunds or failure of water gates to control the ingress of tidal water.

An example of such an occurrence can be seen in one district on the Coast in Selangor, where endemic malaria, transmitted by this mosquito, is found. This is largely the result of invasion by sea water due to faults in the bund.

The result is seen in high spleen rates at the schools which in one instance run about 50%, with a comparatively low parasite rate - 8% at a recent examination. In spite of this the scholars have an air of well-being and the attendance rate is regularly well over 90%.

The spleen rate over all schools in these Coast districts in 1933 was 8.4% while in the Malay schools alone it amounted to 14%. The Malay infantile mortality rate in the district was 133 per mille; it is difficult to estimate what the rate may have been in the specially endemic centres but it was probably much higher. The infantile mortality rate for the Federated Malay States in 1933 was 146 per mille.

Among Estate population, however, in the Coast districts in Selangor the death rate on account of malaria, although there were considerably increased admissions to hospital, amounted to only .9 per mille of the population (43,053) whereas the death rate from bowel disease was 1.6 per mille and from pneumonia 2.3 per mille among the same population.
The death rate among Malays in Selangor (19.5) still remains the lowest among Malays in the Federation in spite of the fact that this endemic malaria is to be found, more especially in the Coast districts, and is slightly below the average for all places in the Federation (19.9).

To reduce the malaria, which is carried by A.sundaicus, it is necessary (a) to introduce a piped water supply so as to eliminate all shallow wells and (b) to make and keep the bunds intact.

This latter method of control may be said to be usually employed in Malaya primarily in the interests of agriculture or to improve the value of land, but there are a number of instances where it has been carried out either solely or mainly to control malaria; notably at Port Swettenham, in the Kapar district and at Kuala Selangor in Selangor, at Port Weld in Perak and at Port Dickson and Lukut in Negri Sembilan.

The rationale of this method is twofold, firstly to prevent the invasion of sea water and secondly to conserve and regulate the amount of water to be retained on the landward side. The initial cost of such drainage works out at *$20 - $25 per acre under control.

Under this heading is included a note on a method suggested by Williamson to control breeding by periodical flushing through the agency of sluice gates; he has reported the successful employment of this method.

* Straits dollar = 2/4d.
in controlling *A. maculatus* at Cameron Highlands at an elevation of between 4000 and 5000 feet. This method has been employed by other workers notably by Paul F. Russell in the Philippines in the control of *A. minimus*.

Experiments have been carried out in Selangor to determine how far this method might be usefully and economically employed in lowland areas, and the preliminary findings of the Institute for Medical Research are given below.

The report remarks that "gates which work satisfactorily as regards the effects of sluicing on larval control have been installed since the beginning of July (1933) in the Sungei Pantai ravine, and since September 19th in the ravine at Bukit Darah". It further remarks that modification and strengthening of the gates as originally recommended have been found necessary and that improvement in design and construction is still possible. Structural difficulties in connection with the installation of gates with the construction of serviceable reservoirs had been encountered.

"As regards cost, it appeared doubtful on the findings to that date whether a saving of expense would be expected from the introduction of sluice-gates into lowland ravines, which would otherwise be dealt with by antimalarial oiling".

There are many possible ways of using the gates by varying the time between flushings, the order in which a series of gates is opened, and the length of time each
gate can be left open. The optimum interval is probably still to be determined, and may vary with circumstances peculiar to each ravine. The flushing may be made automatic.

But experience is necessary in the selection of ravines in which sluice-gate control might be attempted. The cost of installation and upkeep rule out many ravines, especially where dam construction is difficult and much silting is to be expected after each rain-storm.

In the report referred to it was remarked that no justification for the introduction of sluice-gates into lowland areas would appear to exist unless it is possible, under experimental conditions, to demonstrate that sluicing can effect almost complete and certain control of any breeding which is taking place within the area exposed to the action of the flush, that is within the drain and reservoirs themselves.

Further investigation indicates that earlier difficulties have now been largely overcome and that this method of control is of definite and considerable value when employed under suitable conditions. It might have been employed with advantage in the Bukit Wong outbreak referred to earlier.

Recent experiment in Kuala Lumpur has shown that such material as bird lime and white clay although reducing the pH value of the water treated is of no practical value.
However brushwood and herbage, as recommended by Williamson, appear to be of some use, as in the drains in which it was packed anopheline breeding practically ceased although culex continued to flourish unabated. The water thus treated became very foul smelling and this decomposition had practical bearing on the results. Owing, however, to the fact that rain so increased the flow that the brushwood tended to be washed away and that overflow and seepage formation resulted drains had to be dug to at least three times the normal depth. Its application is thus limited in practice. Williamson recently reported on further experiments of packing drains in this way with favourable results so far as elimination of breeding was concerned. It is suggested that this method of treatment by "herbage cover" may be a valuable means of control in rural areas as it is economical and simple in application.

"Senior White has also reported on the value of this method for employment in India.

Seven day oiling is carried out at Kuala Lumpur and a ten day oiling period would be full of risk. Work by the Entomologist at the Institute for Medical Research on the length of the aquatic life of A. maculatus tends to confirm this. He found that adults emerged nine days after a batch of eggs had been laid. It should be decided that in urban areas such as this the policy of weekly oiling should be recommended and continued. Nine and ten day oiling is practised, however, in other areas in Selangor.
Under this heading may be quoted several instances to illustrate what is happening constantly and must be watched for. During 1933 a sudden outbreak of malaria occurred among the servants at the Bungsar Hospital - which is the first class hospital in Kuala Lumpur. This is sited on a hill with broken country around which is all carefully controlled. During this outbreak nine cases of malaria were recorded within a few weeks yet despite the most careful search no breeding place could be found. This latter was probably only of a very temporary nature and no further cases occurred.

An outbreak of malaria of limited proportions occurred within the Sanitary Board area of Kuala Lumpur in 1930. The situation has been summarised as follows. Eighty-three cases of malaria were reported in Kuala Lumpur during 1930, among the population of 120,000. Forty-seven of these cases occurred in low-lying land near a river, where there were several large, weed-grown ponds, in which the most numerous anopheline breeder was A. hyrcanus. The dissection of 300 adults of this species, taken by means of a human bait mosquito-trap, showed an infection rate of 6 per cent - 4 per cent in the gut and 2 per cent in the glands. Five of the midgut infections were due to P. vivax, and six to P. falciparum. Both varieties of A. hyrcanus, viz. sinensis and nigerrimus, acted as carriers. There are some six or eight varieties of A. hyrcanus, two of which namely sinensis and nigerrimus, are found in the Malay States.
The instance of Batu Gajah which has been already quoted where A.barbirostris was involved draws attention to this mosquito as a carrier. The same mosquito was found to be infected during a severe outbreak of malaria at Kampong Acheh on the Province Wellesley Coast in 1926. The epidemic appeared to be transmitted mainly through the agency of A.sundaicus but towards the end of the epidemic A.barbirostris was found to be infected.

In a recent report Vickers and Strahan draw attention to the occurrence of malaria among those living adjacent to rice fields in Kedah. They found that this was transmitted by A.barbirostris breeding in the growing paddi. They came to the conclusion that in rice growing country the principal remedy must largely lie in chemical sterilization of the carriers together with the employment of mosquito nets.

Such incidents as these along with the fact that the incidence of malaria varies seasonally, though not according to any hard and fast rule, demonstrates how essential it is to keep an open mind and a ready imagination in dealing with the many and many sided problems of malaria. It should be remembered, for example, that the 'Wintering' of trees on a rubber estate when the leaves fall may definitely influence the breeding of A.maculatus on that estate.

These facts if they do not necessarily require modifications of technique demand a mind that will readily accommodate itself to fresh ideas and situations.
The next class is (D) where modification is required for aesthetic reasons. A good example is the Gardens at Penang where a hill stream runs through the length of the gardens and of course adds to the beauty and attractiveness of the place. Subsoiling of the rest of the area has been carried out but the stream itself had to be dealt with by spraying with Paris Green. Originally oiling was done but at the request of the Curator this was abandoned in favour of the other method which has proved quite satisfactory, but only under constant supervision.

This method has been suggested as suitable for areas where harm might be done by oiling to growing crops or to domestic animals but one difficulty is in getting complete contact and it must be remembered that culicines are not killed off, at least if the Paris Green is suspended with road dust. It is stated, however, in the Annual Report of the Rockefeller Foundation for 1932, that if combined with charcoal a large percentage of culicines will also be destroyed. It is, of course, a possible method for employment from aeroplanes where large areas require treatment, and it was employed in Calcutta some time ago, and more recently near Delhi. For many reasons, however, it is not considered that this method is of practical value to India in present circumstances.

Experiments have been carried out at Kuala Lumpur as to the value of Paris Green (which is copper-aceto-arsenite with an average arsenic content of 54%,
calculated as arsenious oxide $\text{As}_2\text{O}_3$) on still and moving waters. In the case of the former the results are so far found to be far less effective on the whole than oil and although the costs of application are cheaper any saving can be discounted where oiling methods are in general use.

With regard to its application on moving waters the Health Officer reports that it is again less effective than oiling and that the method demands increased supervision. But it is of definite value where seepage outcrops occur in areas already subsoiled where oiling would tend to render the ground so treated impervious.

In view of these findings treatment by Paris Green cannot be recommended for areas which are densely populated where danger-free methods are essential.

There is an account of arsenical poisoning in man associated with larvicidal treatment of water with Paris Green at Dar-es-Salaam in East Africa, to which attention is drawn. It is stated that this was due to the accumulation and subsequent ingestion of arsenic in water which had been systematically treated with Paris Green.

No such instances have been recorded in Malaya nor, probably, elsewhere. The method of application was that usually described but the areas dealt with were still water pools or holes from which water was liable to be taken for domestic purposes.
Under this heading reference must be made to sites where it is essential that damage to crops should be avoided and it must be kept in mind that material damage to growing crops does occur following contact with oil. During 1932 there was a good example of this in Selangor. Routine oiling was being carried out on an estate above some paddy land and the waste from this, which is enormous in amount under old methods of oiling, entered eventually into this area where the stream was being used for irrigation purposes and destroyed about ten acres of young growing paddy.

There is no doubt that incidents of this kind can be avoided by suitable methods. Better means of oiling as already indicated, where there is little waste effluent, should be employed and waste oil that does come down can in any case easily be trapped or diverted. This incident is also related to (E).

In Malaya very few instances where growing paddy has been shown to be a danger in this respect have been recorded but there is the case referred to earlier. But at the junction of paddy and hill land, which is often found, there may be trouble. Such patches of seepage water can be dealt with by Paris Green which has no deleterious effect on paddy but usually it is sufficient to grow some shade plants over the area and check from time to time. But the peasant must be warned against creating such potential breeding places for A. maculatus without at the same time providing protection
and the effectiveness of this must depend on the institution of propaganda throughout the country.

In this connection it may be noted that the Institute for Medical Research in the 1932 annual report found, after experiment, that antimalarial oiling had little, if any, deleterious effect on poultry. In the experiment it was reported that "for a period of two months the experimental birds had had their water supply continuously covered with a film of anti-malarial oil. Such conditions would not obtain in their natural life, when only minute quantities of the oil would occasionally be taken". It thus appears that anti-malarial oiling is unlikely to have any seriously deleterious effect on the health of poultry.

The Health Officer, Kuala Lumpur, states in his annual report for 1933 that it was found that oiling had apparently no adverse effect on fish in the areas oiled. But this cannot be accepted as a uniform finding and the point must be kept in view where it is proposed to oil ponds that are maintained solely for the purpose of fish breeding.

The stocking of ponds and other breeding places with imported larva-eating fish such as "Millions" has not been employed with success in Malaya as a practical antimosquito measure. A local species termed "Ikan Mata Lallat" (Haplochilus Panchax) is useful however and reduces mosquito breeding.
With regard to (E) where it is essential to preserve the subsoil water for domestic or agricultural purposes there are occasions where no pipe or other permanent supply of water is available where it is important not to cut off by subsoil drains water percolating to wells etc. The working population often depends on such a source for water for domestic purposes and will not view with equanimity any action cutting off such water without providing an alternative supply.

Reference has already been made to an example of this kind at Tanjong Tokong village on Penang island. The first effect of subsoiling at the hill foot was to empty the shallow wells and it was only possible to deal with that difficulty by extending the pipe line and introducing the town supply.

Another instance was at Glugor in Penang where the water supply was that derived from wells but additional water was saved for domestic purposes by trapping the discharge of the subsoil drainage in a suitable manner. This practice has been followed in many parts of the country and has helped to retain the goodwill of those concerned and make antimalaria draining popular instead of the reverse.

Nothing antagonises the peasant so much as some mistake in tactics whereby a shortage of water results or from action whereby standing crops are damaged by crude oil, and in initiating any scheme all the possible consequences must be kept in mind. Much harm can be done
through thoughtless, hasty and ill-considered action which it may take years to eradicate.

A first principle in all work of this nature is to secure the goodwill of those concerned. The ways by which this may be attained are sometimes devious and not always direct but this must be kept prominently in view in any scheme of propaganda which precedes the work and assurance should be given to the occupier that no damage will result to his water supply, to his cattle, to his crops or to anything that he values.

There now falls to be considered somewhat briefly the question of (F) antimalarial work in relation to the care of a special class of population.

The classes of population that one would naturally have in mind in this relationship would be (1) persons confined in institutions such as prisons, quarantine camps and leper settlements, (2) travellers by land and air, (3) the Defence Forces on land, and (4) labour forces on rubber estates and on mines. In connection with all these classes there are points of special interest in the methods of antimalarial control that are or should be adopted.

Where a concentrated population in gaols, hospitals and such like is concerned very careful antimalarial control must be undertaken in the neighbourhood - such control including of course the elimination
of parasite carriers. Control in the case of prison population is definitely assisted by the fact that discipline can be exercised and instructions given that will be carried out. The main prisons in Malaya are all carefully controlled from this point of view and it is an interesting fact that in most of them very few mosquitoes of any kind are seen.

In the gaol at Alor Star where between 400 and 500 prisoners are housed there was for many years remarkable freedom from malaria although mosquito nets were not used and the same applied to some other gaols in the country. In Taiping although malaria occurred from time to time in the neighbourhood it is, or was, practically unknown among the gaol population. Every gaol is enclosed by a wall some 16 feet in height and it may be that this factor is responsible to some extent for the absence of mosquitoes in such institutions.

This fact was noted by the writer as far back as 1914. It was then recorded that at the Reformatory (in Singapore) no first attacks of malaria were noted, that is, boys infected at the Reformatory, in spite of the fact that at almost any time during the year A.maculatus could be recovered from a site not distant more than fifty yards from the Reformatory building. No imagines of this mosquito were caught in the Reformatory which is on an elevation of about 50 feet above this breeding ground and 100 feet above mean sea level.
In the case of leper settlements every effort must be made to control the mosquito and insect population as a whole in view of the undetermined although unlikely possibility of the conveyance of leprosy through the agency of biting and other insects.

The leper settlements of the Straits Settlements are sited on islands and the risk of such conveyance is practically eliminated. In the case of the Sungei Buloh settlement in Selangor a very complete scheme for the control of mosquito fauna has been in force since the opening of the settlement in 1930, and the occurrence of indigenous malaria in these settlements is rare.

Minor but sharp outbreaks of malaria occurred however among the lepers at Sungei Buloh both in 1932 and 1933. The Health Officer traced the former to breeding just outside the settlement following the cutting of a path through jungle and the exposure to sunlight of a certain area. This incident serves to stress the importance of complete co-operation between all Executive departments in relation to antimalarial control.

Where no source of breeding can be discovered in such instances the possibility of the unauthorized temporary exit of members of these communities must be kept in mind; it is quite possible that this theory might explain certain facts but some outbreaks are extraordinarily difficult to track to a source.
In the case of railway travel by night in Malaya the ideal would probably be to have sealed carriages with conditioned air circulated at a suitable rate and temperature. Extraction fans can easily be rendered mosquito-proof if fitted with balanced light metal louvres which open and shut according to the action of the fan connected with them or blades could no doubt be devised to seal themselves when at rest. This should be kept in mind in the case of mosquito-proofed wards where it is very desirable to exhaust effete air from the ward at intervals, especially during the night. The panels in wards or railway carriages should be constructed so that they can be opened or removed during the day time and through currents of air introduced.

With regard to railway travelling it should be noted that any system of sealing carriages presents difficulties, more especially in connection with third class traffic where there is considerable movement among passengers alighting at intermediate stations. The procedure adopted by the Railway department of mosquito-proofing sleeping carriages and employing insecticide has proved reasonably satisfactory but is not devoid of risk to the passenger, in view of the large area of unprotected country that is traversed in passing through the Peninsula. Any means of control demands the full co-operation of those to be protected and this, at least so far as the third class passenger is concerned, is almost impossible to ensure.
Recently certain coaches on express trains have been air-conditioned and coincidentally rendered mosquito-proof. When this is carried through completely railway travel in Malaya will be revolutionized and the risk of infection by malaria practically eliminated. One has only to have experienced travelling during summer months in trains across the Continent of America, which has had air-conditioned coaches for a number of years, to realize the added comfort that this means.

In so far as passengers travelling by air are concerned any method to deal with those arriving from malarious districts would be part of the routine laid down for dealing with aircraft arriving from places infected with certain diseases. In the International Sanitary Convention for Aerial Navigation (1933) certain measures are detailed for employment in the case of aircraft coming from places where the endemcity of yellow fever is suspected, in which yellow fever has occurred or exists in endemic form, or in respect of territories or regions in which yellow fever does not exist, but in which there may be conditions which permit of its development. These measures include inspection of aircraft either on departure or arrival or both, disinsection, and examination of passengers and crew, and within section one and articles four, five and six, the matter of establishing "sanitary aerodromes" is dealt with together with the requirements for these. The latter include facilities for the isolation of sick and stipulate that
a sanitary aerodrome shall at all times have at its disposal the apparatus necessary for carrying out disinfection, disinsectisation, and deratisation if required, as well as fulfil any other requirements stipulated in the Convention.

Furthermore on the main flying routes in such places mosquito-proofed dwellings are provided for the accommodation of passengers and crew and such protection would be provided in Malaya where the need arose.

Investigations on the destruction of mosquitoes in aircraft are being pursued at present in British India; at present "Pyrocyde 20" is used with a pressure pump. Other recent work has led to the conclusion that in certain types of aircraft the automatic destruction of mosquitoes during the voyage sometime before landing might be possible and result in a considerable gain in time. The apparatus used for this purpose produces a spray of insecticide by means of "sparklets" of C.O₂. in the case of the freight holds and by mechanical pumps in the accommodation for passengers. While this is in progress the aeroplane has, of course, to be sealed and draughts excluded.

The protection of members of the Defence Forces from malaria more especially while on active service is an important matter and one which must constantly be kept under consideration and review. In peace time it is mainly a matter for the Health establishment belonging to
such units but during war the civil authorities may be called upon to advise either as the Health authority for a district or by becoming for the time being members of such Forces.

In addition to the general measures of control that call for application where such are practicable under service conditions there may be a number of modifications of such measures that become necessary in such circumstances.

During the Great War much experience of malaria under service conditions was acquired in the war zones in Palestine, Salonika and even in France, and this experience must be applied in similar circumstances in the future. In such zones as that of France the constant comparatively low temperature and short summer season checked mosquito propagation and diminished the possibility of any serious outbreak of malaria although indigenous malaria occurred on that Front. This was just as well because A.maculipennis could be found in almost any shell hole containing water in such low lying country as the Ypres salient. This is well within the knowledge of the writer because during the summer of 1915 he was detailed to make a mosquito survey within this area.

Most up to date experience on active service is available in the reports on malaria among the army in India which are published from time to time. One of the chief points to be kept in mind is (a) the sterilization
and elimination of parasite carriers; this is analogous to sterilization in the case of other infective carriers.

It is rarely possible to carry out any antimalarial work to protect troops that are on the move; this is possible only in exceptional circumstances where troops are held up for a long period in one area.

Another point closely associated with (a) is (b) the prophylactic use of drugs. The Public Health Commissioner with the Government of India in his annual report for 1932 makes some remarks on this point which are relevant. He is dealing solely with the question of the use of prophylactic drugs "capable of administration in such amounts and at such times that the soldier's ordinary life and work are in no way interfered with and he asks the question "what is a malaria prophylactic"? He goes on to define this as "a drug which entering the blood stream kills the parasites of malaria before they have reached that stage of development which manifests itself in the clinical signs and symptoms of the disease. The drug must be persistent in action and its effect continuous over the whole period which separates the administration of any two doses, and it must exercise its effect in prophylactic, in contradistinction to, therapeutic doses".

In answer to the question he asks himself whether such a drug exists and expresses the opinion that there is no known drug with such properties.

He remarks that "the army in India forms a big and controlled field suitable for clinical and
Addendum to 'A Study of Malaria' etc. - to be included with Page 46 at the end of the last complete paragraph on that page.

The following extract from the Palestine Annual Report of the Department of Health for 1936 brings out well the manner in which routine measures of anti-larval control served to protect troops on duty in Palestine from malaria.

"A practical demonstration of the satisfactory reduction of endemic malaria which has been achieved by the constant anti-larval measures of previous years was afforded during the military activities which were carried on throughout the whole of the malarious season, April to November. Military patrols operated on roads and railways by day and night, picquets and guards were stationed in many parts of the country and frequent operations involving the movement of considerable bodies of men for several days on end over large parts of the country were executed. The troops for the most part were young soldiers susceptible to malaria infection and inexperienced in methods of personal prophylaxis. The total number of cases of malaria which occurred in the forces the total strength of which eventually reached a maximum of 15,000 was 117 primary cases and 22 relapses. Of the primary cases, 55 or practically half the total number were contracted in two localities where no anti-larval measures have been carried out by the Department. This indicated that the routine anti-larval measures of the Department rather than procedures of personal or therapeutic prophylaxis were mainly responsible for the protection of the troops from malaria infection in other parts of the country."

The average spleen rates among children in urban areas and rural districts were in 1936 1.77% and 6.68% respectively.
epidemiological investigation; so suitable that its advantages as such would be weakened or might even disappear were the factor of lapse of time to be disregarded'.'

With regard to quinine used prophylactically it was reported that no apparent benefit followed. In one station certain units were kept as controls but in these the malarial incidence was no higher than in the "protected" units. The prophylactic value of plasmoquin was tried out on a large scale in Burma and "on the whole, the results were moderately good" but they presented "a too favourable picture, since the cases were not followed up to the beginning of the next recognised malaria season". With regard to atebrin this was introduced into army practice too late in 1932 to permit of definite conclusions being reached at that time regarding its comparative value.

The problem of malaria prophylaxis in respect of the Defence Forces of Malaya is of importance commensurate with the large establishment now in Singapore and elsewhere in the Peninsula. Generally speaking attention will be concentrated on elimination of the mosquito vector, as heretofore.

Early experiments were carried out by Hoops in the prophylactic use of atebrin to protect Estate labour in Malacca. At that time (1933) he doubted whether atebrin had any prophylactic effect as a true preventive of malaria; he found later that it was "the
best drug available for the controlled treatment of all types of malaria in Malaya".

Wallace carried out similar experiments in Kedah on a number of Estates. In some Estates anti-larval measures were employed as well and in some cases plasmoquin was combined with the atebrin. The malaria rate was practically nil during the period of administration and although many thousands of coolies were treated no serious toxic effects were noted.

Work done by Soesilo in the Dutch East Indies had not been conclusive but experiments with atebrin-treated volunteers over one complete year had been favourable. Barrowman also deals with this question, but more from the point of view of treatment.

Investigation was carried out by Field during 1935 and 1936 on atebrin and quinine administered as clinical prophylactics to malarious populations in the course of which 1733 individuals were observed for periods up to twelve months, and 1174 malarial attacks treated. The findings were that the efficacy of atebrin as a prophylactic had been amply demonstrated and "collateral experiments with prophylactic quinine are being continued to afford a direct comparison of both the efficacy and cost of the two methods". This was an interim report only: a further report was published later by Field, Niven and Hodgkin.
It was found that both atebrin and quinine effected a marked reduction in the number of attacks of malaria and that the risks attendant upon the prolonged use of atebrin, under medical supervision, were "very slight". The results of these investigations point to the efficacy of this method of dealing with the problem of malaria among a controlled population, either as the method of choice or as accessory means of prevention.

To sum up, special stress might be laid on three aspects of this problem. Firstly that proved methods of control, which have stood the test of time and experience, should not be lightly discarded; these are the methods described and advocated by Watson, and others, many years ago. Secondly, that it is essential to keep an open mind and use imagination in dealing with this problem. And, thirdly, that research and investigation must be linked with practical experience in the field and with changing conditions, as these occur. Special reference to propaganda need not be made here because the need for education in this field has always been kept in the forefront in Malaya; and perhaps it may be fairly added, having in mind the record of progress in Malaya, so has the essential attitude of mind that is portrayed earlier in this paragraph.
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APPENDIX.

1. Table of Anti-malaria Expenditure in Selangor, 1933.


5. Cameron Highlands - approximate total length of road under oiling at one time.


7. Population and Sickness Table of Labour at Cameron Highlands, 1929.
### Table of Anti-Malaria Expenditure in Selangor, 1933

<table>
<thead>
<tr>
<th>District</th>
<th>Total Oil Expended (Gallons)</th>
<th>Total Cost of Oil Including Transport</th>
<th>Cost of Necessary Labour</th>
<th>Cost of Fresh Work Only</th>
<th>Total Cost of Fresh Work Including Labour</th>
<th>Total Cost of Fresh Work and Maintenance on Temporary and Permanent Work</th>
<th>Miscellaneous Expenditure Including Temporary Supervision and Controlled Areas</th>
<th>Total Expenditure for Current Year</th>
<th>Cost per Work Carried Out</th>
<th>Miscellaneous Expenditure</th>
<th>Maintenance of Existing Work</th>
<th>Grand Total Expenditure on A.M. Work</th>
<th>Amount of Oil Expended</th>
<th>Amount of Oil Expended</th>
<th>Amount of Oil Expended</th>
</tr>
</thead>
<tbody>
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<td>1. Kuala Lumpur</td>
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<td>6004.98</td>
<td>5932.30</td>
<td>553 1/2</td>
<td>545.33</td>
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<td>2862.12</td>
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<td>3. Selangor</td>
<td>16,613</td>
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<td>11988.84</td>
<td>2885.30</td>
<td>26462.30</td>
<td>75 1/2</td>
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<td>5. Long</td>
<td>4682</td>
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<td>545.27</td>
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<td>2107.25</td>
<td>2227.35</td>
<td>5724.03</td>
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<tr>
<td>6. Selangor</td>
<td>3589</td>
<td>574.21</td>
<td>323.80</td>
<td>70 1/2</td>
<td>115.60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1314.46</td>
<td>734.26</td>
<td>3062.36</td>
<td>31 1/2</td>
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<tr>
<td>7. Bukit Riam</td>
<td>2320</td>
<td>355.96</td>
<td>190.20</td>
<td>3</td>
<td>1.60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>796.59</td>
<td>533.55</td>
<td>1876.30</td>
<td>31 1/2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>90982</strong></td>
<td><strong>15634.85</strong></td>
<td><strong>18112.65</strong></td>
<td><strong>684 1/2</strong></td>
<td><strong>702.31</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td><strong>42753.89</strong></td>
<td><strong>40890.78</strong></td>
<td><strong>11494.18</strong></td>
<td><strong>39 1/2</strong></td>
</tr>
</tbody>
</table>

*Figures supplied by Public Works Department.*
MALARIA NOTIFICATIONS IN KUALA LUMPUR TOWN 1928 - 1933

KUALA LUMPUR 1933

Relative Humidity

Rainfall in Inches

Number of Cases Notified

Number of Cases Originated in Kuala Lumpur Town

Chart No. IV
## DR. VICKERS' NEW BRUSH-SPRAY-MOP SCHEME.

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimated population</th>
<th>Actual Annual expenditure including only &quot;larval control&quot; action in areas under permanent measures</th>
<th>Actual Earth ditches used</th>
<th>Earth revenue collection from privately owned areas in which anti-malarial work is done</th>
<th>Resultant cost to State per annum if whole of the K.L. controlled area was under an oiling and ditching scheme</th>
<th>Estimated maximum cost to State per annum</th>
<th>Estimated per capita cost to State per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1931</td>
<td>112,660 (Census)</td>
<td>$66,189.71</td>
<td>86464</td>
<td>14299</td>
<td>$7,560.30 + $58,529.41 + $76,000.00 + $0.67</td>
<td>$0.67</td>
<td>$0.67</td>
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<tr>
<td>1933</td>
<td>120,300</td>
<td>$42,409.80</td>
<td>33664</td>
<td>15098</td>
<td>$11,577.38 + $31,582.42 + $45,000.00 + $0.37</td>
<td>$0.37</td>
<td>$0.37</td>
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</tbody>
</table>

**N.B.** (x) The 1933 figures given above exclude the new area taken in during that year for comparison purposes. The inclusion of this area would further reduce the per capita cost to the State as the "..." was done under column 6 above. 1932 figures are omitted as both the old and new schemes were in operation that year.

**N.B.** The Kuala Lumpur "Brush-Spray-Mop" technique differs from the "Quaife brushing method of oil application" in the following main respects: (a) mops only used in the latter while the sprayer is the chief medium of application in K.L. (b) the K.L. method covers all types of breeding places which can be encountered in an area such as K.L. and can be used from the commencement of any operations in an area. Quaife advocates a heavy spraying campaign in the first instance for a year or two and notes the inapplicability of his method in areas of widely distributed seepage: (c) the K.L. method average minimum length of drain oiled to the gallon of 26 chains. Quaife 10 or more chains according to the width of the drain treated.
Summary of Costs of Bamboo Drains at Kuala Lipis, 1931 - 1932 - By Dr. E.A. Struthers.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>$45.37 p.a.</td>
<td>$69.72</td>
<td>$5.64 p.a.</td>
<td>$120.00</td>
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<tr>
<td>II</td>
<td>99.71 &quot;</td>
<td>189.80</td>
<td>16.92 &quot;</td>
<td>795.00</td>
</tr>
<tr>
<td>III</td>
<td>96.72 &quot;</td>
<td>165.36</td>
<td>11.28 &quot;</td>
<td>250.00</td>
</tr>
<tr>
<td>IV</td>
<td>30.72 &quot;</td>
<td>47.07</td>
<td>5.64 &quot;</td>
<td>60.00</td>
</tr>
<tr>
<td>V</td>
<td>12.66 &quot;</td>
<td>33.77</td>
<td>5.64 &quot;</td>
<td>50.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>285.18 p.a.</td>
<td>505.72</td>
<td>45.12 p.a.</td>
<td>1275.00</td>
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Cameron Highlands - Approximate Total Length of Road Under Oiling at One Time.

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<tr>
<th>Date</th>
<th>Length</th>
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<tbody>
<tr>
<td>Late 1925</td>
<td>2 miles</td>
</tr>
<tr>
<td>Early 1926</td>
<td>4 &quot;</td>
</tr>
<tr>
<td>Later 1926</td>
<td>9 &quot;</td>
</tr>
<tr>
<td>Early 1927</td>
<td>11 &quot;</td>
</tr>
<tr>
<td>Later 1927</td>
<td>13 &quot;</td>
</tr>
<tr>
<td>Early 1928</td>
<td>15 &quot;</td>
</tr>
<tr>
<td>Later 1928</td>
<td>20 &quot;</td>
</tr>
<tr>
<td>Early 1929</td>
<td>24-27 &quot;</td>
</tr>
<tr>
<td>Later 1929</td>
<td>20 &quot;</td>
</tr>
<tr>
<td>Early 1930</td>
<td>17 &quot;</td>
</tr>
<tr>
<td>- 1930</td>
<td>9 &quot;</td>
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</table>
MONTHLY RETURN SHOWING EXPENDITURE ON

ANTI-MALARIAL WORK, CAMERON HIGHLANDS, 1929.

<table>
<thead>
<tr>
<th>Month</th>
<th>O I L</th>
<th>Labour</th>
<th>Total Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gallons</td>
<td>Cost</td>
<td>Cost</td>
</tr>
<tr>
<td>January</td>
<td>2055</td>
<td>$606.73</td>
<td>$1,537.59</td>
</tr>
<tr>
<td>February</td>
<td>1918</td>
<td>535.52</td>
<td>1,392.55</td>
</tr>
<tr>
<td>March</td>
<td>2101</td>
<td>618.58</td>
<td>1,915.68</td>
</tr>
<tr>
<td>April</td>
<td>1625</td>
<td>517.59</td>
<td>1,461.50</td>
</tr>
<tr>
<td>May</td>
<td>2439</td>
<td>648.74</td>
<td>1,515.25</td>
</tr>
<tr>
<td>June</td>
<td>2661</td>
<td>706.54</td>
<td>1,579.55</td>
</tr>
<tr>
<td>July</td>
<td>2234</td>
<td>594.36</td>
<td>1,553.90</td>
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<tr>
<td>August</td>
<td>2235</td>
<td>573.30</td>
<td>1,439.90</td>
</tr>
<tr>
<td>September</td>
<td>1241</td>
<td>456.20</td>
<td>1,120.85</td>
</tr>
<tr>
<td>October</td>
<td>1614</td>
<td>458.84</td>
<td>958.30</td>
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<tr>
<td>November</td>
<td>1292</td>
<td>395.85</td>
<td>697.00</td>
</tr>
<tr>
<td>December</td>
<td>2062</td>
<td>571.29</td>
<td>1,138.20</td>
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<td>Total</td>
<td>23,477</td>
<td>$6,683.54</td>
<td>$16,310.27</td>
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<td>MONTHS</td>
<td>POPULATION</td>
<td>HOSPITAL ADMISSIONS</td>
<td>DEATHS</td>
</tr>
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<td>-----------</td>
<td>------------</td>
<td>---------------------</td>
<td>--------</td>
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<tr>
<td></td>
<td>Indians</td>
<td>Chinese</td>
<td>Malays</td>
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<td>JANUARY</td>
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<td>2165</td>
<td>140</td>
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<tr>
<td>FEBRUARY</td>
<td>475</td>
<td>1673</td>
<td>130</td>
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<td>MARCH</td>
<td>591</td>
<td>1791</td>
<td>134</td>
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<tr>
<td>APRIL</td>
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<tr>
<td>MAY</td>
<td>738</td>
<td>1820</td>
<td>100</td>
</tr>
<tr>
<td>JUNE</td>
<td>755</td>
<td>1608</td>
<td>96</td>
</tr>
<tr>
<td>JULY</td>
<td>656</td>
<td>1550</td>
<td>110</td>
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<tr>
<td>AUGUST</td>
<td>595</td>
<td>1229</td>
<td>98</td>
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<tr>
<td>SEPTEMBER</td>
<td>533</td>
<td>1123</td>
<td>102</td>
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<tr>
<td>OCTOBER</td>
<td>601</td>
<td>1289</td>
<td>96</td>
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<tr>
<td>NOVEMBER</td>
<td>631</td>
<td>1114</td>
<td>112</td>
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<tr>
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<td>1255</td>
<td>96</td>
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<tr>
<td>TOTAL</td>
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<td>18527</td>
<td>1333</td>
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<tr>
<td>AVERAGE</td>
<td>610</td>
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+ Includes 73 'Chronic Malaria' given anti-relapse treatment.