Proceedings of the Imperial Malaria Conference : held at Simla in October 1909.

PROCEEDINGS

OF THE

IMPERIAL MALARIA CONFERENCE

HELD AT

SIMLA

IN

October 1909.

SIMLA:
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Delegates to the Imperial Malaria Conference.

INDIA.

1. Surgeon-General F. W. Trevor, C.B., V.H.S.,
Principal Medica. Officer, His Majesty's Forces in India.

2. Lieutenant-Colonel C. P. Lukis, M.D., F.R.C.S., V. H. S.,
Officiating Director-General, Indian Medical Service.

3. Lieutenant-Colonel J. T. W. Leslie, M.B., C.I.E., I.M.S.,
Sanitary Commissioner with the Government of India.

4. Lieutenant-Colonel D. Semple, M.D., R.A.M.C. (retired),
Director, Central Research Institute, Kasauli.

5. Lieutenant-Colonel H. B. Thornhill, C.I.E., I.A.,
Inspecting Officer of Cantonments.

6. Lieutenant-Colonel A. R. Aldridge, M.B., R.A.M.C.,
Sanitary Officer, Army Head Quarters.

7. Major S. P. James, M.D., I.M.S.,
Statistical Officer to the Government of India in the Sanitary and Medical Departments.

8. Captain S. R. Christophers, M.B., I.M.S.,
Assistant to the Director, Central Research Institute, Kasauli.

MADRAS.

9. The Hon'ble Mr. C. J. Weir, I.C.S.,
Member, Board of Revenue.

10. Major C. Donovan, M.D., I.M.S.,
Professor of Physiology, Madras Medical College.

11. M. R. Ry., Diwan Bahadur B. Narayanamurti Pantulu Garu,
Retired Deputy Collector and now Diwan, Lady Gajapathi Rao's Estate, Vizagapatam.

BOMBAY.

12. Lieutenant-Colonel T. E. Dyson, M.B., I.M.S.,
Sanitary Commissioner for Bombay.

13. Mr. H. S. Lawrence, I.C.S.,
Collector of Sukkur.

14. Mr. J. A. Wadia,
Bombay.

BENGAL.

15. Mr. W. Maude, I.C.S.,
Commissioner, Patna Division.

16. Major L. Rogers, M.D., F.R.C.P., F.R.C.S., I.M.S.,
Professor of Pathology, Calcutta Medical College.

17. The Hon'ble *Rai* Kishori Lal Goswami *Bahadur*, M.A., B.L.,
Member, Provincial Legislative Council.

18. Captain A. T. Gage, M.B., I.M.S.,
Superintendent, Royal Botanical Gardens, Calcutta.

UNITED PROVINCES.

19. Mr. H. C. Ferard, C.I.E., I.C.S.,
Officiating Commissioner, Allahabad Division.

20. Lieutenant-Colonel J. Chaytor-White, M.D., I.M.S.,
Sanitary Commissioner.

21. The Hon'ble *Rai* Sundar Lal *Bahadur*, C.I.E.,
Second Additional Judicial Commissioner, Oudh.

PUNJAB.

22. Colonel T. E. L. Bate, C.I.E., I.M.S.,
Inspector-General of Civil Hospitals.

23. Lieutenant-Colonel G. F. W. Braide, M.B., I.M.S.,
Inspector-General of Prisons.

24. Mr. C. M. King, I.C.S.,
Deputy Commissioner, Gurdaspur.

25. *Rai Bahadur* Gopal Das Bhandari, Pleader, Chief Court, Amritsar.

BURMA.

26. Colonel W. G. King, M.B., C.I.E., I.M.S.,
Inspector-General of Civil Hospitals.

27. Mr. N. G. Cholmeley, I.C.S.,
Commissioner, Magwe Division.

28. Captain Maung Ba-Ket, M.B., I.M.S.,
Civil Surgeon, Pegu.

EASTERN BENGAL AND ASSAM.

29. Mr. R. Nathan, C.I.E., I.C.S.,
Commissioner, Dacca Division.

30. Major E. Wilkinson, F.R.C.S., I.M.S.,
Officiating Sanitary Commissioner.

31. The Hon'ble Maulvi Saiyid Nawab Ali Chaudhuri, *Khan Bahadur.*

CENTRAL PROVINCES.

32. Mr. M. W. Fox-Strangways, C.S.I.,
Financial Commissioner.

33. Major W. H. Kenrick, I.M.S.,
Civil Surgeon, Khandwa.

34. *Rao Bahadur* R. N. Mudholkar, B.A.,
Pleader, Amraoti.

VISITOR.

Dr. A. D. Cooper,
Baroda City.

IMPERIAL MALARIA CONFERENCE, OCTOBER 1909.

AGENDA PAPER.

Date of meeting.	Time.	Place.	Subjects.
Tuesday, 12th October	11 A.M.	Viceregal Lodge ...	1. ADDRESS BY HIS EXCELLENCY THE VICEROY. 2. Paper by the Sanitary Commissioner with the Government of India, on the Problem of malaria in India.
Wednesday, 13th October.	10-30 A.M.	Committee Room, Railway Board Office.	DISCUSSION ON THE DISTRIBUTION OF MALARIA IN INDIA; opening remarks by *Major S. P. James, I.M.S.* *Papers to be read.* A new statistical method of ascertaining the prevalence of malaria, by *Captain Christophers, I.M.S.* Malaria in the Central Provinces, by *Major Kenrick, I.M.S.*
Thursday, 14th October.	10-30 A.M.	,, ...	DISCUSSION ON EPIDEMIOLOGY. *Papers to be read.* Malaria in the Punjab, by *Captain Christophers, I.M.S.* DISCUSSION ON MEASURES. *Papers to be read.* Difficulties of anti-malarial measures, by *Colonel W. G. King, C.I.E., I.M.S.* Malaria in Cantonments, by *Lieutenant-Colonel H. B. Thornhill, C.I.E., I.A.* The propagation of small fish as a means of limiting malaria, by *Lieut.-Colonel Chaytor-White, I.M.S.*
Friday, 15th October	10-30 A.M.	,, ...	DISCUSSION ON MEASURES, *continued.* *Papers to be read.* Summary of anti-malarial measures in the Punjab, *compiled under the direction of the Inspector-General of Civil Hospitals, Punjab.* Problems relating to the use of quinine, by *Major S. P. James, I.M.S.* The most useful salt of quinine for general use in malarial tracts, by *Major Donovan, I.M.S.*
Saturday, 16th October	10-30 A.M.	,, ...	DISCUSSION ON MEASURES, *continued.* *Papers to be read.* A scheme for the distribution of quinine, by *Major Wilkinson, I.M.S.* Experimental demonstration camps, by *Major S. P. James, I.M.S.*
Monday, 18th October	10-30 A.M.	,, ...	Suggestions and conclusions.

FIRST DAY.

Tuesday, October 12, 1909.

PRESENT.

His Excellency the Viceroy and Governor General of India.

His Honour the Lieutenant-Governor of the Punjab.

The Honourable Sir Herbert Risley, K.C.I.E., C.S.I., I.C.S., Member of Council in charge of the Home Department.

Sir Harold Stuart, K.C.V.O., C.S.I., I.C.S., Secretary to the Government of India, Home Department.

The Delegates to the Conference.

His Excellency the Viceroy opened the Conference with the following address:—

GENTLEMEN,

I must in the first place welcome you heartily to Simla. I assure you I fully appreciate the strain that a break in the every-day work of busy men must always cause—to say nothing of the personal inconvenience of the long journeys many of you have had to undertake And I recognise too the public spirit of the local Governments who have deputed officers to represent them in your coming deliberations, who could not be easily spared from the important posts they fill.

But, gentlemen, the subject which I have invited you to Simla to discuss has seemed to me of such vital importance as affecting the health and therefore the welfare of the vast populations of this country, that it could not adequately be dealt with by local effort—or rather that local effort would be far more likely to succeed if the general principles upon which the ravages of malaria are to be combated were discussed by a central assemblage in possession of a full knowledge of all local characteristics and possibilities. There are many conditions which may influence local Governments in the line of action they may think it best to adopt. But, on the other hand, we appear to me to be confronted with certain facts not only as to the deplorable results of a terrible sickness, but as to well-ascertained means of counteracting them,—facts which demand the joint consideration of all local authorities and the joint acceptance of the plan of campaign it may be advisable to adopt.

It is with this view that I have convened an Imperial Conference on Malaria. It rests with the Conference to discuss a great hygienic problem, and I have been anxious that in the composition of the Conference the Government of India should have the benefit not only of expert but of administrative and lay opinion. I need hardly tell you that on hygienic matters I am myself a layman, and it is with the utmost humility that I venture to address the galaxy of expert talent I see before me. But still the people of India are laymen like myself—we know of a dread disease and of a dismal death-roll; we read of the weapons with which we are told it can be effectually fought, and we look to you as experts to help us.

I am afraid that very often in this world of ours it requires some sudden crisis to bring home to us the existence of an evil which has long been in our midst. Malaria is no new ailment. The cruel epidemic which raged last autumn in the United Provinces and in the Punjab exceptionally emphasised its dire consequences and has impressed upon public opinion the magnitude of the question with which the Government of India is called upon to deal, yet

we must remember that much as the Punjab and the United Provinces have suffered, there are many districts in Bengal where the people have died in thousands during past years and where the strength of the population has been undermined. Malaria has been a terrible scourge in many parts of India. I have no wish to weary you with a repetition of statistics which are no doubt well known to all of you, but speaking generally, the number of deaths ascribed to fever in the whole of India has varied during the last 10 years from about 4 millions to 4½ millions per annum: and though it is admitted that only a portion of these are due to malaria, and though we cannot say with precision what that proportion is, it has been estimated to be from one-fourth to one-fifth of the total number of deaths entered in our returns as due to fever. We may therefore take it that malaria is answerable in an ordinary season for about a million deaths in the year. But last year the number of deaths ascribed to fever was one million more than the normal, and there are grounds for belief that this additional million was due to malaria, and not to the other diseases which go to swell the total returns under the heading of fever. We may therefore assume that the number of deaths from malaria in India are ordinarily one million, but that in an exceptional season they have risen to two millions. If we admit such a conclusion, as I am afraid we must, we cannot disguise from ourselves the magnitude of the evil with which we have to deal. And the loss by death is by no means the whole of that evil. There are the cases of those who contract the disease, but do not die, and the ratio of the number of such cases to the number of deaths is very high. I believe one estimate has placed it as high as 133 cases of sickness to one death. If therefore we take it only in the proportion of 50 to 1, we have to admit 100 million cases of fever for last year which were not fatal. It is appalling to think of the suffering and economic loss that such conditions imply—not only direct and immediate loss by the death and sickness of adults, but potential loss in the case of the children. And yet much of this widespread suffering scientists assure us is preventible. The chief problem before the Conference will be to discover by what means that assurance can best be confirmed.

I have already told you, gentlemen, that I am addressing you entirely as a layman. I am in no way entitled to enter the arena of scientific hygienic discussion, but I gratefully acknowledge the debt of gratitude we owe to the comparatively recent discoveries of the secret history of the world-wide disease this Conference has assembled to consider. We all know the old theories about malaria,—the Italian derivation of the word illustrates them: *mala aria*, bad air; air tainted by injurious emanations from animal or vegetable matter; noxious exhalations of marshy districts; in other words miasma. It has too been ascribed to the 'Sirocco', that disagreeable wind, the relaxing effects of which are, I am sure, known to any of you who have frequented the shores of the Mediterranean. Those were the beliefs of old days, and it was not till 1880 that Laveran, a French Army Surgeon, discovered the malarial parasite and his views were not accepted until they were confirmed some years later, by Italian scientists. In 1894, Sir Patrick Manson suggested that the malaria parasite probably had some kind of mosquito as an intermediate host which was necessary for its development, and it was only in 1897 that, acting on that suggestion, Major Ross made the brilliant discovery which I may perhaps venture to say solved the problem of the etiology of malaria and earned for him not only the admiration of scientists, but the thanks of the world at large. Major Ross's discovery has been put to practical test in Italy, Panama, Ismailia, and at other places, and there would seem to be no reason to doubt that if man can be protected from the bites of infected mosquitoes, he will not contract malaria. This however confronts us with another problem—is it always possible to exterminate a particular kind of mosquito from malarious localities? The answer I venture to think rests rather with the administrator than with the doctor and man of science. I am afraid, gentlemen, I have not the hardihood to enter into the controversial atmosphere which surrounds the question—I must leave it to you to decide to what extent the malaria mosquito has been personally vanquished in the past or can be utterly defeated in the future. Much must depend upon the development of sanitation, upon carefully considered organisation, and last but not least, upon financial possibilities. But

however that may be, whilst readily admitting the value of the great discoveries to which I have referred, we are mercifully, in our struggle with malaria, not merely confined to the direction of an anti-mosquito campaign. We have other means of attack at our disposal. For there is ample evidence of the marvellous results due to the administration of quinine as a prophylactic—I of course mean as a prophylactic administered upon systematic and well-thought-out lines. Dr. Osler—Regius Professor of Medicine at Oxford—in a letter to the *Times* in the spring of this year told us his experiences of preventive treatment of malaria in Canada. The same treatment has also met with marked success on the Panama Canal, whilst in Italy in malarial districts quinine is distributed in the shape of comfits and chocolates. Dr. Bentley has written in the same sense of his experiences in India, and Lieutenant-Colonel Braide has told us of the very satisfactory results due to prophylactic treatment in the prisons of the Punjab under his charge. So that the Conference will have before it two important facts, Major Ross's discovery of the actual cause of malaria, and the evidence, which I think we may assume to be incontrovertible, that where quinine can be systematically administered as a prophylactic, a very general immunity from malaria will be the result. It will rest with the Conference to decide by what means the knowledge of these two great facts may best be utilised. The practical application of that knowledge must involve the consideration of many points of detail upon which it would be useless for me to enter to-day, but which will require much careful and searching enquiry—as a basis for which the Conference will, I am glad to say, have before it an able paper by Colonel Leslie embodying his proposals for the systematic investigation into the possible prevention and treatment of fevers.

Gentlemen, I have only attempted to outline the general conditions, as they appear to me, surrounding the consideration of the problem with which you will have to deal—a problem of Imperial magnitude—inasmuch as it affects the health and happiness of this great country—the successful solution of which must depend upon the united efforts of the administrations and varied interests which you have assembled here to represent. It is my earnest hope that the results of your deliberations may—by the inauguration of a campaign against what we now know to be a preventible disease—confer a great boon upon the people of India and though the campaign must of necessity be long and hard fought, I open this Conference in the firm belief that it will eventually be crowned with success.

The following paper was then read :—

Malaria in India

BY

LIEUTENANT-COLONEL J. T. W. LESLIE, M.B., C.I.E., I.M.S.

Before beginning the regular business of this Conference it seems to be desirable that you should have before you a rough sketch of the position of the problems of which we are to endeavour to find some solution, namely, the reduction of the amount of malarial infection in India and the mitigation of the results of infection.

A reference to any recent Report of the Sanitary Commissioner with the Government of India will show that out of a total number of about eight million deaths recorded during the year, 4½ millions were registered under the heading "fever." Many people assume that all these fever deaths are due to malaria, but a very cursory examination of the details of the statistics will show that this assumption is erroneous. If, for instance, we turn to the statistics recorded in Sind in 1907, we find that the total death rate was 22·4 per 1,000, including a death rate from fever of 19·2. If all the deaths which appear under the heading "fever" had been due to malaria, all the other diseases to which flesh is heir caused only 3·2 deaths in every thousand of the population. This is obviously absurd. If we now look at the statistics of Karachi for the same year, we find that the total death rate—unhappily very high owing to the prevalence of plague—was 49 per thousand, including a death rate from fevers of 7 per thousand. As a matter of fact, the

registration of vital statistics in India, except in a few of the towns, is carried out by means of an illiterate agency, and although in many provinces the total figures are surprisingly correct, the registered causes of death are always very misleading. The heading "fever" represents pneumonia, tubercle of the lungs, diseases of the kidneys, and indeed, all the so-called medical diseases, except diseases like cholera and small-pox of which the distinctive signs are unmistakeable by the people themselves.

The total number of deaths registered under the heading "fever" is remarkably constant from year to year, the figure being a little short of 4½ millions, and the mean death rate rather less than 19·5 per thousand. During the last ten years death rates have been raised owing to plague, but we may say that if, in a given year, the total Indian death rate was 35 per thousand, four-sevenths of it, or 20 per thousand, would be ascribed to fever.

The question that at once occurs is, "what proportion of this death rate of 20 per 1,000 is due to malaria?", and obviously, in the circumstances in which deaths are registered, this is an exceedingly difficult question to answer with any degree of accuracy, but from the indications afforded by certain special enquiries, from the dispensary reports, and other sources, it has been estimated for the whole country at about one-fourth, that is to say, the mean death rate from malarial fevers, in an ordinary year, and taking the country as a whole, is about 5 per thousand. This means that in an ordinary year malaria causes about 1,130,000 deaths, and as in such a year it is not a very fatal disease, this number of deaths represents an enormous amount of suffering and loss of labour, often at the time when labour is of most value. It is impossible to judge of the amount of suffering or to frame an estimate of the economic loss, because we have no trustworthy data regarding the degree of fatality of the disease among the people.

A rough idea of the extent to which death from malaria is preventible in India may be formed from a study of the effects of the disease in the Native Army and in jails, but, of course, in any comparison of the statistics referring to soldiers and prisoners with those of the general population, we must not omit to make allowance for the age and sex constitution of the populations compared, and for the peculiarly favourable conditions in which preventive measures act among bodies of men under skilled control.

The Native Army consists of picked men who, when they are with their regiments, are looked after carefully in health and skilfully tended when sick. The admission and death rates ascribed to malaria have declined in recent years, but during each of the ten years ending with 1907 it may be said that three men in every 2,000 died from its effects.

Prisoners are greatly inferior to soldiers in physique and they are subject to the depressing effects and monotonous routine of jail life. Moreover, there is a continuous flow into and through the prisons of individuals, many of them infected with malaria, taken from the lowest and poorest ranks of society. Still, far more stringent measures of prevention are possible in jails than in regimental lines, and the results are consequently better, so far as malaria is concerned. In each year of the decennium, on an average, four prisoners in each 3,000 died from malarial fever.

When the deaths ascribed to malaria in the jails are closely investigated, it is found that in a considerable proportion of the cases death was due to a cause other than malaria, so that the mean death rate of the ten years, which on paper is 1·30 per thousand, is in fact only about 1 per thousand. That is to say, the death rate among prisoners from malarial fevers is about one-fifth of what it is among the general population. A comparison of a death rate among prisoners with that among the general population is misleading owing to the numbers of children and old people among the latter, but preventive measures are by no means perfect in the prisons, and perhaps we may say that if we could place all the people in fairly good hygienic conditions, give them prophylactic doses of quinine during the fever season and provide them with suitable food and skilled attendance when they are attacked, we should prevent three-fourths of the deaths from fever that now occur. This is perhaps rather speculative—certainly there are a good many

'ifs' about it. Our experience in prisons does show this, malarial fever properly treated is by no means a fatal disease among adults. Last year (1908) malarial fevers were extraordinarily prevalent and fatal in north-western India. During the year there were 20,039 cases of fever admitted into the jail hospitals throughout the country, and only 105 of those cases terminated fatally. Assuming that all the 105 died from malaria, which the *post mortem* records show was by no means the case, this means that only one in 191 cases of fever ended in death, and this in a year when the fever was peculiarly deadly. Contrast this with the state of affairs among the general population in the United Provinces in 1908, when one person in every 24 died of fever—in that year mostly malarial. Why is it that a disease which is so rarely fatal to a prisoner should be so often fatal to a free man?

A very large fraction of the total mortality from fever among the general population occurs among children and the aged, and in epidemic years they suffer disproportionately, because in such years, for reasons which we shall presently mention, they have to suffer from privations which loosen their feeble hold on life. In the Punjab in 1908 the infantile death rate from fever was doubled and the fever death rates among children between the ages of 1 year and 10 years of age were more than doubled. While due allowance must always be made for the share of the total mortality occasioned by malaria among the very young, it seems to me that, in normal years at any rate, there is sometimes a danger of exaggerating it, for it is not uncommon to find practically all the deaths occurring in infancy attributed to malarial fevers. Now we know that, in temperate climates, where there is no malaria, the mortality in infancy even in favourable circumstances is high; and in a tropical or sub-tropical country with a very high birth rate, we cannot expect children to escape the effects of mal-nutrition, bowel complaints, parental ignorance and other special dangers of childhood.

In normal years I believe many of the deaths which result from malarial fevers are directly due to the treatment, or rather want of treatment of the cases. I do not refer to the neglect of medicinal remedies, but to the withholding of food. In this country and in some others it is an article of popular superstition that a fever should be starved, and the sufferer and his friends believe that the taking of food brings on the attack of fever. Too often it is the sufferer that is starved and not the fever.

In any place in which malaria exists meteorological conditions may determine a severe epidemic of fever, when the disease becomes not only much more common, but enormously more fatal than in ordinary years.

When heavy rains precede a severe outbreak of fever, they cause floods, when large tracts of country are submerged, houses collapse, harvests are destroyed and the poorer classes of the peasantry are not only thrown out of employment, but are exposed to great privation and hardship. It is then that the mortality among children and the aged is so high—malaria, owing to the simultaneous occurrence of exposure and privation, has become a very fatal disease. These are obvious considerations, but there are others which have not yet been fully elucidated. The floods, of course, produce lasting pools of water in which mosquitoes breed, but a feature of these autumn epidemics is the suddenness of their onset, which it seems can be accounted for only by large numbers of mosquitoes being very rapidly infected.

In the towns, in India as in other countries, there are numbers of people who lead a hand to mouth existence; ill-housed, ill-clad and ill-fed, they pick up a precarious livelihood in the unskilled labour market. Such people have unsuitable food at the best of times, and they have no savings, so that when anything occurs to check the demand for such work as they can do, the scanty coarse food becomes scantier and coarser and they and those dependent on them offer little resistance to malarial infection and readily succumb to its effects.

Analogous conditions, as pointed out by Christophers and Bentley, may be artificially produced in any area in which anopheles mosquitoes can breed, when large numbers of labourers are collected in it under bad hygienic conditions. The majority of such labourers are free from infection, but are highly susceptible to it, a few are infected, and all are dependent on their daily labour for their daily

bread. Infection spreads and with it the inability to earn money to pay for sufficient food, privation added to malaria determines a severe attack, attacks are repeated and here again the disease is a very fatal one.

The cause of malaria is a sporozoan parasite of which there are three species generally recognized. These parasites pass the sexual phase of their lives in certain mosquitoes and the asexual phase in the blood of man. The important fact in respect of the prevention of malaria is that in nature the parasites occur in both hosts and, so far as is known, nowhere else.

Preventive measures are founded on this fact and have for their object the destruction of the insect host, the prevention of the transference of the parasites from one host to the other, or the destruction of the parasites in the blood of man.

It is unnecessary to enumerate in detail the devices which have been used to effect these objects, they may all, I think, be classified under three heads.

(1) The extermination of mosquitoes.

(2) The prevention of bites.

(3) The administration of quinine.

The prevention of bites is useful as a supplement to more radical measures but, so far as this is effected by wire gauze screens and mosquito curtains, which are expensive and require careful handling, the use of the measure must be limited to the wealthier classes.

Much I believe could be effected by improving the design of living rooms and dormitories. It seems obvious that a well ventilated white-washed room will afford less shelter during the day to mosquitoes than a dark dingy room. Anointing the body with substances offensive to mosquitoes is useful on occasion.

Of the two radical measures, one aims at the extirpation of mosquitoes by abolishing their breeding places or destroying the eggs, larvæ or mature insects, the other aims at destroying the sporozoan by the administration of quinine, and there has been much controversy regarding the merits of the two measures. It has always seemed to me to be unfortunate that so many of the writers who contribute their views on this controversy to the public press have not been at the pains to study the original accounts of the experiments on which any opinion of value must be based. The consequence of so much wild writing has been to confuse the issue, and not only the intelligent layman, but even medical men have been led astray.

It is obvious, if malaria is due solely to the bites of anopheles mosquitoes, that the extirpation of these mosquitoes will abolish malaria. It will be admitted by everybody that the continuous use of quinine, even for a short time during the year, is inconvenient and unpleasant to the individual and difficult to carry out among a community. It is therefore evident that the best way to get rid of malaria is to destroy the mosquitoes. The only questions are. Can it be done ? and, if it can, at what cost ? It has been successfully done at Ismailia, but in conditions which were extraordinarily favourable, such, as I fear, occur very rarely, if they ever occur, in India.

Ismailia was built about 35 years ago by the Suez Canal Company as a model town. It is situated on the shore of the bitter lake Timsah, with the desert behind it. The water supply is derived from the fresh water canal.

In his report to the Liverpool School of Tropical Medicine, published in January, 1903, Major Ross pointed out that "almost the whole of the irrigation system of Ismailia is free from larvæ and is unfavourable to their propagation" and that "the waters which really occasion malaria are the most shallow and insignificant surface pools, which could be filled up and drained away without difficulty and without detriment to cultivation or irrigation," indeed, he remarked, "mosquitoes can be extirpated with great facility at Ismailia, in fact with much greater facility than in any other town I have seen." Fever is said to have appeared in Ismailia in 1877, but it was never severe, and only three or four pernicious attacks had occurred from the commencement of the epidemic

until 1902. Major Ross says "The illness does not appear to be of such a severe type as I have met with in parts of India and Africa; and no deaths have been reported."

The population of the town is 7 or 8,000; the Canal Company is the controlling force everywhere; there are no prejudices to overcome; there is no lack of money; the soil is sandy and the rainfall averages less than two inches in the year. Compare these conditions with those of any malarious town you know in India. The Ismailia experiment proves that the extirpation of mosquitoes to a degree sufficient to abolish malaria is possible, and so far it is a valuable lesson to Indian administrators, but surely it is futile to say that because success was achieved at Ismailia it should be achieved in the same manner in Indian towns. I have said nothing of the expense.

We may now turn to a place where operations against mosquitoes were less successful—Mian Mir. This cantonment was deliberately chosen by the Royal Society's Commissioners, to whom Captain James was attached as a representative of the Government of India, (1) because malaria was prevalent in it, and (2), because it was thought that the conditions for the destruction of mosquitoes were favourable. The Royal Society's Commissioners' experience in Africa had led them to doubt the practical value of operations against mosquitoes in the moister regions of the world, but they thought that such operations would be successful in the semi-desert conditions of Northern India. Mian Mir differs from Ismailia is most particulars, two of which are of special importance—the soil is impervious and the rainfall averages about 22 inches. The first year's (1902) operations were carried out by Captain James. His conclusion was that "mosquito destruction if it can be carried out successfully, will effectually banish malaria," and "the chief drawback to mosquito destruction is its difficulty and expense".

The second year's (1903) operations were carried on by Lieutenant Christophers. His conclusions were—

"The destruction of anopheles within an area by attacking their breeding places is extremely difficult. Although large numbers of pools were filled up and drained, and millions of larvæ destroyed by oil, adult anopheles were still abundant.

"The mere obliteration of local breeding-places is useless. In Mian Mir almost complete absence of breeding was ensured to a distance of over half a mile, but adults still appeared in large and increasing numbers in the area.

"A distinct effect was produced upon the malaria of troops and on the endemic index of the bazars. This was, however, only evident in the beginning of the fever season, and could not be maintained.

"The failure of the operations appeared to be due to the passage of adult anopheles into the area from without."

A great deal was learned from the operations in Mian Mir. Before they were undertaken it was thought that fever carrying mosquitoes bred in still pools of water, and could fly at most for a few hundred yards. It was discovered at Mian Min that fever carrying mosquitoes breed not only in pools, but in running water and that they can fly for half a mile; consequently such operations as can be carried out by a mosquito brigade were of very little use in Mian Mir. The critics of the operations did not, however, pause to consider matters of this kind, "Why," they said, 'did you limit your operations to an area of four miles?,' "What," they continued, "is the use of filling up and oiling puddles when there are channels of running water in which anopheles breed?"

It seems to me that this was hardly fair.

The second phase of the Mian Mir experiment began with the extensive works undertaken by the military authorities; the results obtained will, I hope, be fully examined elsewhere.

Before leaving Mian Mir there is one matter to which reference must be made. It has been said that the failure of the operations at Mian Mir has led to

the neglect of anti-mosquito work in India. I do not think this is the case. All the Mian Mir experiment showed was that success in operations against mosquitoes is not so easily gained as some people say, and no one who reads the excellent reports by Major Ross on the work at Ismailia and by Captain James and Lieutenant Christophers on the work at Mian Mir will deny that this is correct. During the last ten years the energies of local Governments and municipalities have been very fully occupied in dealing with plague, and less money has been available for the prevention of malaria than might otherwise have been the case. But a great deal has been attempted. If we have erred in giving too much attention to quinine prophylaxis and too little attention to mosquito destruction, we have erred in the best company. Professor Angelo Celli of Rome, whose experience is greater than that of anyone else, at any rate in Europe, finds that, although the destruction of mosquitoes is possible in the laboratory and in small areas the difficulties in extensive areas are generally insuperable.

Important information regarding malaria in villages was obtained by the Drainage Committee appointed by the Government of Bengal in 1906 to enquire into the conditions of the drainage of the Presidency Division and their connection with malaria. Captain Stewart and Lieutenant Proctor of the Indian Medical Service were the experts appointed to assist the Committee. In the districts of Jessore, Nudia and Murshidabad, they found that malaria as estimated from the spleen rates of children under 12 years of age, was, on an average, much less prevalent in villages situated on the banks of live rivers and on dry land than in villages situated on the banks of dead rivers or *bheels*, while in villages surrounded by thick jungle the spleen rate (68·8) was more than twice as high as that (26·2) in villages with little jungle around them—the effect of the thick jungle being to afford shade from the sun and check the evaporation of water from small hollows in which mosquitoes breed.

The success or failure of minor operations against mosquitoes appears to me to depend upon the state of the drainage. Where drainage is perfect, as in the case of Ismailia, the inhabitants can exterminate mosquitoes with little trouble ; but where drainage is non-existent or bad, as at Mian Mir, it is practically impossible, by any means at present within their reach, for the inhabitants to destroy the mosquitoes.

In any scheme, then, which has for its object the removal of malaria from an area, the first step is to ascertain the condition of the drainage and, if it is imperfect, how it can be improved so as to prevent water-logging of the soil, not only in ordinary seasons, but in seasons of extraordinary rainfall. In the drier parts of India it seems it is abnormally heavy rainfall that is the danger. Last year in the west of the United Provinces the monsoon rainfall was about normal, but all the rain fell in two months, and fever was severely epidemic ; in Berar the monsoon rainfall was 24 per cent in excess, but it took nearly four months to fall, and fever was less prevalent than usual. Drainage schemes are costly and they require a long time to carry out even when the funds are available, and in the meantime the choice must often be made between measures against mosquitoes and the administration of quinine—unless, as may often be the case, it appears to be advantageous to use both these measures.

In making the choice all the circumstances of the case must be taken into consideration. To take extreme examples. If we have a town containing a few pools which are the only sources of the anopheles mosquitoes infecting the inhabitants, it is obvious that the remedy is to drain or fill up the pools. If we have a small village surrounded by a swamp in which anopheles breed, it is evident that quinine prophylaxis is the best remedy. In India we have all the gradations between these two extremes, but those approximating to the village in the swamp are in the enormous majority.

An obstacle that has stood in the way of quinine prophylaxis is the doubt entertained by the general public and some members of the medical profession of its efficacy. This doubt is in most cases founded upon experience—medical men have found persons who have apparently been regularly taking quinine get fever, and most practitioners have come across cases in which quinine seemed to fail to cure malarial fever, while instances

are not uncommon in which the results of quinine prophylaxis in a community have been exceedingly unsatisfactory. Sometimes the cause of failure is not far to seek—the drug has not been taken at all, the dose has been insufficient, or it has been taken irregularly. There are other instances, however, that are by no means easy to explain, and whoever has studied the recent researches into the fate of quinine in the animal body—of which Major James will give us a resumé—will recognize how thickly beset with difficulties the subject is and how great is the necessity for further research, particularly in this country which differs so widely from Europe in respect of the food of the people, metabolic changes and conditions of climate. It is possible that a race of malarial parasites that is immune to quinine may be developed. Fresh water amoebae may be gradually habituated to salt water, the infusorian Stentor kept in a weak solution of corrosive sublimate becomes tolerant of a solution containing four times the quantity of the poison that is fatal to stentors taken from pure water. Trypanosomes frequently develope in an animal being dosed with atoxyl, a race of trypanosomes that is immune to that drug, and they produce descendants in a new animal host which retain this immunity. Giemsa and v. Prowazek succeeded in obtaining races of Colpidia that could live in fairly strong solutions of quinine. The parasite of malaria is far more closely adapted to its normal surroundings than the protozoa I have mentioned, but it seems possible that quinine-fast plasmodia may be produced, and we may speculate regarding the nature of such an immunity and whether it would be retained after sexual reproduction and passage into a new human host. Persons infected with quinine-fast parasites would be in an unhappy position.

It appears, however, that the prejudice against the use of quinine as a prophylactic entertained by a few medical men is hardly logical. If it is admitted that quinine is *the* remedy for malarial fever and that it acts by killing the malarial organisms—propositions which few medical men will be found to deny, it is surely reasonable to believe that it will be as useful as a preventive as it is as a cure. When it is realized that it is fatal to the vegetative form of the parasite, but may be ineffectual against the sexual forms, it will be admitted that it is even more useful as a preventive than as a cure.

There is much evidence accumulated in this country to show that quinine swallowed regularly in sufficient doses is very nearly a complete preventive of malarial infection, or at any rate of the clinical manifestations of malarial fever. The most striking evidence of the kind is afforded by Colonel Braide's experiment in the Punjab in the autumn of 1908.

The use of quinine as a prophylactic was introduced into the Punjab jails many years ago by Colonel Bate, and its use in them has been continued with ever increasing stringency and success. Colonel Braide attempted an experiment on a great scale in 1907, but he failed to get his orders properly understood, and it was certainly fortunate that his great experiment was reserved for the autumn of 1908, almost the most malarious in the history of the Punjab. During the four months—August to November, 1908—every prisoner on admission to jail was given 10 grains of quinine in the presence of the medical superintendent, and thereafter received 15 grains once a week. The results were very remarkable. The admission rate from malaria, including in it the rate on account of 'pyrexia of uncertain origin,' was 173·5 per thousand, the lowest on record, and the malaria death rate of the year was the lowest with one exception. That this result was not contrived by classifying cases of malaria under some other disease heading is evident when the general admission rates from all diseases are studied. In 1908 this rate was 581·2 per thousand; in 1907 it was 706·8; and the mean of the five years ending with 1906 was 890·5. A success of this kind justifies a very critical examination of any reported failure.

I have laid stress upon the danger of comparing the statistics respecting the inmates of our prisons with the statistics of the general population, and I think it would be just as unsafe to believe that because quinine prophylaxis may, with considerable difficulty, be made a complete success in prisons it will be equally successful among the people. The prisoners are under great advantages, their lives are regularly ordered, they are well housed, well fed, protected against the vicissitudes of the weather, and rarely undergo any exceptional

bodily exertion. Quinine is given to them systematically in sufficient doses under supervision, and when they are attacked by fever every means is used to ensure the quinine acting at an advantage. Among the general public many know that quinine is a remedy for malarial fever and are eager to get it when they are suffering, but many are prejudiced against it, and probably the majority have never heard of it. We shall therefore have to take means to bring the advantages of quinine before all those who live in malarious places, and not only eradicate prejudices, but educate the people to use the quinine in sufficient quantity and at the right time. I fear these will prove to be very hard tasks.

The best preparations for the use of adults and children will have to be selected; and probably much will depend upon the way in which the drug is dispensed.

The correct dose must be determined, and I think it would be of advantage to issue the drug in tabloids or powders equal to the minimum dose sufficient for prophylactic purposes, with directions that the single dose should be repeated a certain number of times at specified intervals as a cure.

It is essential, I think, that it should be recognised that the distribution of quinine cannot be made self-supporting, and in view of economy, if for no other reason, very careful enquiries will be necessary regarding the needs of different localities. In many places no quinine is necessary at all; in others it is required only for a short time in certain years; in others it is required every year, but only at a certain season, and in yet others there is need for its continuous use.

It is clear, therefore, if we are adequately to carry out the distribution of quinine on a great scale, that special provincial agencies will have to be established for the work. The distribution of quinine is one of the questions with which this Conference is specially to deal so that it is not necessary to do more than mention some of the more important matters to be settled.

Although our knowledge of the etiology of malaria and its treatment is fairly extensive, it is still wanting in continuity and completeness, and the scientific study of its epidemiology is only beginning. Some of the gaps in our knowledge regarding the possibilities in the life cycle of the parasite must be filled before we can hope to master the epidemiology of the disease to which it gives rise, and we cannot devise the simplest and best preventive measures until the epidemiology is thoroughly understood. As I have endeavoured to indicate, we have little exact knowledge of the distribution of malaria in the country, of the local conditions which favour it, and of the best means to render these causes inoperative. I think the time has come when we should establish a permanent organisation for dealing with malaria in India.

It will be evident that the defects in our knowledge may be classified as follows—

(*a*) Questions of administration, *e.g.*, the best agency for the distribution of quinine.

(*b*) Questions that can be solved by experts on the spot, *e.g.*, the causes of disease and death and the distribution of malaria in a district; and

(*c*) Questions that can be solved only by highly trained experts with the resources of a well appointed laboratory at their disposal.

The organisation I would propose is the following—

I. A Committee in each province of three or more members personally interested in the malaria problem, enjoying the confidence of the local Government and prepared to obtain information and supervise local enquiries. They should, perhaps, control the agency for the distribution of quinine. One of their first duties would be (in association with the provincial Sanitary Department) to ascertain the real causes of death in different localities, and to set in motion an enquiry in each district regarding the relation of the fever season to the drainage and rainfall.

II. Every autumn each provincial committee would delegate, under the orders of the local Government, one of their members to attend a meeting of a General Committee in Simla. This General Committee would consist of the provincial delegates, the Sanitary Commissioner representing the Government of India with Major James as Secretary.

III. The Government of India would appoint a Scientific Committee consisting of Lieutenant-Colonel Semple, Major James (Secretary), Captain Christophers and the Sanitary Commissioner, with power to add to their numbers.

A certain number of workers would be entertained under the Scientific Committee, and, when necessary, workers might be deputed to serve under the provincial Committees. Such workers during the time of their deputation would, of course, be under the control of the local Committee, but, in order that the purpose of the whole organisation should not be defeated, relations of mutual confidence would exist between the central and local Committees, and there would be free interchange of views, not only on the occasions of the annual meeting, but by means of correspondence at all times.

His Honour the Lieutenant-Governor of the Punjab made the following speech—

On behalf of the Punjab, and perhaps I may venture to say on behalf of all the local Governments, I thank Your Excellency and Your Excellency's Government for having summoned this influential Conference to deal with what is perhaps the most important sanitary and administrative question in India. In view of the numerous experts in medical service and administration and the Indian gentlemen here assembled we may hope with some confidence that the vital problems mentioned in Colonel Leslie's able paper will receive the fullest consideration and that a solution of some at least of our difficulties may be found.

The Punjab has bulked largely in Colonel Leslie's paper, and perhaps as the head of this Province I may be allowed to add a few words on the general question before the Conference proceeds to attack it in detail. It is a curious fact that in the Punjab when we are involved in epidemic disease the results are ordinarily more strikingly disastrous than elsewhere. This holds good especially in the case of malarial fever. It has been my good fortune to have spent most of my service amongst the people as a district and settlement officer and I can speak with full knowledge of the terrible ravages that malaria causes. Epidemics of small-pox, cholera, and plague, are grievous afflictions but neither singly nor even collectively are they responsible for so much economic inefficiency and what is worse actual human misery as the recurrent scourge of malaria. To cope adequately with this curse of the country has been my chief endeavour since I assumed charge of this Government. Colonel Bate and Colonel Braide will explain what measures the Punjab Government has adopted and how far they have been successful. I am confident that the results of the deliberations of this Conference will materially help me in my task. It is a curious fact that most of the severe epidemics of malaria in recent years in the Punjab with which I have been brought into personal contact have been associated with a cataclysmal downpour of rain in the months of July and August, and it is perhaps a still more curious fact that the epidemic has almost synchronised with the downpour, as Colonel Leslie has noticed. I remember the heavy rains of 1880 and the resultant epidemic in Amritsar when that unfortunate City lost 15,000 people in three months from malaria. In 1890 there was heavy rainfall in the Punjab submontane, and the high uplands of the Gujrat, Sialkot and Gurdaspur districts were decimated. This tract is singularly dry and free from stagnant ponds and no doubt the question why fever should have visited it in such a way, will be duly considered. In 1892 I was in Peshawar. It was thought that the dreaded Peshawar fever had died out owing to sanitary improvements and the introduction of a pure water-supply. In July and August of that year we had 20 inches of rain against an average of perhaps two and this was followed by an appalling out-break of the worst type of Peshawar fever, and the returns of the Army will show how the troops suffered. Our experience of last year has been noticed by Colonel Leslie, but it was very similar. I venture therefore to suggest for

your consideration, gentlemen, why these out-breaks follow so closely upon these downpours. There must be other causes than those mentioned by Colonel Leslie, and if you can discover them you will have done well indeed by the Punjab.

I will conclude my remarks by again thanking Your Excellency for your gracious action in convening this Conference from which we all hope so much for the country and its peoples.

The Conference then adjourned.

SECOND DAY.

Wednesday, October 13, 1909.

PRESENT.

The Honourable Sir Herbert Risley, K.C.I.E., C.S.I., I.C.S., *President.*

The Delegates.

The President.—I should like to say a word or two about arrangement and procedure. As to arrangement we have grouped the representantives of the various provinces together so that they can consult and concert their attack upon the reader of the paper. As to procedure, first of all the paper will be read, and I should like to say here that I propose to curtail the reading so that as much of the actual time as possible can be devoted to discussion. This is in accordance with the practice in England. The British Association, for example, allow ten minutes which they as a favour extend to a quarter of an hour. I think that is reasonable; what we want to get is as much discussion as possible and we desire to waste as little time on the mere reading of papers already printed as is possible. After the paper has been read I propose that there should be a full discussion of the proposals made. That is what we want to get at. We know the scientific doctrine and want to bring the experience of the representatives of the various provinces to bear as to the way in which this or that proposal can be given effect to. I shall take notes of the discussion to the best of my ability and shall then endeavour to formulate a provisional conclusion expressing the sense of the Conference. I have no doubt that on the last day when we put the provisional conclusions together we may find it necessary to modify and adapt a little so that the conclusions may accord with each other and be arranged in a connected manner.

The following paper was then read :—

Remarks introducing a discussion upon the distribution of Malaria in India

BY

MAJOR S. P. JAMES, I.M.S.

I have been asked to introduce the discussion upon the distribution of malaria in India, but as this important subject can be dealt with adequately only by those who have personal knowledge of many localities in each province my remarks will be as few as possible. The object of ascertaining the distribution of malaria accurately and definitely is that we may be able to state in what parts of the country measures are advisable, in what parts they are essential, and in what parts they are not only essential but urgent. Every province—and possibly every district of every province—contains areas that are highly malarious and areas that are not at all so, and before we begin to consider the particular kinds of anti-malarial measures to be adopted we must, by mapping out those areas, obtain exact knowledge of the magnitude of the task that lies before us. Upon this knowledge may depend entirely the decision in regard to the measures that will be undertaken. It is obvious, for example, that if a province were so fortunate as to possess only a few highly malarious areas it might be possible, by concentrating the resources of the province on those areas, to undertake and bring to a successful issue much more radical schemes than could be entertained in a province where, on account of the disease being almost everywhere prevalent, funds and effort are required in numerous areas. I think this truth is not sufficiently recognised. Many people still believe that anti-malarial measures are required almost everywhere in India and that for this reason the magnitude of the task is to be measured only by the area of the country and the number of the inhabitants. There are still people who go to the trouble of working out the cost of distributing quinine to the whole population of a province. Such calculations serve no useful purpose and

the appalling figures which result from them tend to discourage effort. But if instead of proceeding to ascertain the magnitude of the task by such methods, an attempt were made in the first place to define the exact distribution and comparative prevalence of malaria in the province, the result might quite possibly show that the expense of dealing with the disease would be only moderate in comparison with the total revenues of the province. For example, even a cursory examination of the death rates from fevers in the Madras Presidency indicates that the areas in which measures are urgently required cannot be numerous and that the task of dealing sufficiently with malaria in this Presidency may be by no means one of great magnitude. Indeed if we assume that at any rate for a number of years all our efforts should be concentrated upon the mitigation of malaria in places where such efforts are urgently required—and I take it that this means in places where the disease is seriously interfering with prosperity and with the natural increase of population—I doubt if there are half a dozen considerable areas in the Madras Presidency which would come in that category. Again it is, or was until quite recently, a common belief that Assam as a whole is intensely malarious but the truth is that a great part of that country is only very slightly malarious and that in some areas the disease does not occur. I believe that the same may be true even of a country with so bad a reputation for malaria as Burma. It is true also of such small sub-divisions as districts and even of cities and towns; it often happens that only parts of these places are highly malarious. It is therefore unfortunate that even at the present day one can give a number of instances in which, owing to lack of exact knowledge of the distribution and comparative prevalence of the disease, money and energy are being wasted upon areas where malaria is so slightly prevalent as to call for no special measures. It will now be clear why I stated in the beginning of my remarks that the distribution of malaria in India can be dealt with adequately only by those who possess intimate local knowledge. When the subject was decided upon for discussion at this Conference it was hoped that time would permit the collection and compilation of statistics that might afford at any rate some useful general indications for guidance in regard to the parts of India where measures against malaria are most necessary, but it was clear that the areas for which statistics are compiled in the central offices of the Government of India are necessarily so large that no results based upon them would provide information that could be regarded as of much value for the purpose mentioned. And indeed, I think, I am correct in saying that owing to the very unequal distribution of malaria, no statistics are of much value for that purpose except such as relate to much smaller areas than those for which any figures are at present anywhere published. Captain Christophers will deal with this aspect of the problem and will show what misleading results may be arrived at unless the principle of working upon the statistics of small areas is followed. Colonel King also will doubtless tell us that whereas in the Madras Presidency, if we were to deal with the statistics of the province as a whole or even with those of districts, we might conclude that no measures against malaria are urgently required, we have only to consider the statistics of small areas to realise how necessary such measures are in certain tracts. I think, then, that this is the first principle to adopt in an endeavour to state the distribution of malaria in India, and I venture to submit to the Conference that an investigation similar to that which Captain Christophers has made in the Punjab should be begun in every province.

The only other subject to which I desire to refer is the necessity of ascertaining, for as many areas as possible in each province, what proportion of the deaths recorded under the heading fever by the existing agency for the collection of vital statistics is due to malaria. From a recent issue of the *British Medical Journal* I see that even at meetings of learned bodies in England the well-worn phrase, "few of us realise that in India alone nearly five million lives are the annual tribute exacted by malarial fever," is still called into service when occasion offers, and the fact that a statement so incorrect still gains credence is in itself sufficient reason for enquiry to establish the extent to which it is erroneous. A more important reason is that in the absence of local investigations by skilled workers such enquiries are an essential preliminary to any attempt to state the distribution and prevalence of malaria. The Sanitary Commissioner with the Government of India told us yesterday that for India as a whole about 20 to 25

per cent of the deaths recorded as due to fever might reasonably be considered as being caused by malaria. But it is obvious that while this is an accurate estimate for India as a whole, it is less accurate for the different provinces considered separately and much less accurate for many smaller areas. So far as I am aware Bengal and the United Provinces are the only parts of India in which systematic enquiries on the subject have been instituted and an examination of the results of those enquiries shows that in future certain errors incidental to pioneer investigations might be avoided. I submit, then, that the necessity of carrying out a number of enquiries of this nature is a subject well worthy of discussion and that among other details an attempt should be made to decide the number of such enquiries that are advisable in each province, the staff requisite for their conduction, the duration of the enquiry in each area, and the chief points to which prominence should be given in any instructions drawn up for the guidance of officers in charge of them. When used upon the working basis of the statistics collected by existing agencies, the knowledge derived from a series of careful enquiries by a professional agency in selected areas of every province would be of very great service in an attempt to ascertain the areas in which measures to mitigate malaria are urgently required.

The following discussion ensued :—

Colonel Lukis.—Two points have been raised by Major James in his paper, the first may very well be left over until Captain Christophers has read his paper, because that will give us a much more complete idea of what action is necessary in order that we may ascertain the most malarial districts. I agree with Major James that it is necessary for those who deal with a subject of this nature to possess local knowledge and therefore I hope that the various delegates who are present to-day will state their views as regards the unequal distribution of malaria to which Major James has drawn attention. On the point in his paper as to the necessity of an accurate diagnosis with a view of arriving at correct figures as to how much of our fever mortality is due to malaria, I agree with what he says, for although 25 per cent may be taken as a general average it must vary very greatly in different areas, and I am quite sure that in certain parts of the country there are diseases which very largely mask the proportion of the death rate that is due to malaria. It must be remembered that under the head of fevers we have to include not only malaria and *kala azar*, but enteric fever, Malta fever, and in some parts of the country relapsing fever, dengue, and a very large number of cases of septicæmia. I think therefore that a careful investigation is necessary in the different parts of this country and that this investigation might be undertaken on the same lines as the investigation made last year in Bengal. Possibly the Bengal delegates may be able to give us some information regarding that investigation.

Colonel King thought that the presence of malaria must depend on certain physical conditions and that therefore the only question that remained was, given a malarious area, was the intensity of the disease always the same or did it vary from time to time? He thought it would vary under seasonal conditions and especially when the conditions were such as to alter the level of the subsoil water. He agreed with Major James regarding the question of localisation and it was the most important point which the Conference had to consider. He agreed also with Major James that in the Madras Presidency and also in Burma the localisation of malaria is very marked. He then referred to the question of Registration. It was well known that this was a difficult point. As regards the remark that in future certain errors incidental to pioneer investigations might be avoided, Major James had probably in mind the employment of special experts; his own view was that each province should depend upon itself as much as possible for its investigations; there were certain conditions which required expert knowledge but for ordinary routine work every province should have an organized agency, one capable of taking up the question of malaria systematically and continuously.

Major Donovan wished to know more about the investigations carried out by Captain Christophers.

The President said localization was easy to understand. In the district in which he served some years ago there were three areas, the alluvial, laterite and

coast. In the first Burdwan fever was raging, in the laterite there was no fever, in the coast there was fever only during the rains. Obviously statistics of the whole district would throw no light on the state of things. What it was necessary to know was what was to be the methods of investigation and what was to be the agency for carrying it out. Was it to be the Civil Surgeon, or the Sanitary Commissioner and his staff, or was it to be done by special officers. The question of cost would come in and would have to be looked to.

Major James, referring to Colonel King's remarks, said that there had been some misunderstanding. The object of his remarks was to show that they must not begin the discussion of particular kinds of measures to be taken against malaria until they had made some arrangements for determining the distribution and relative prevalence of the disease. In his paper he had drawn attention to two quite distinct subjects in regard to which arrangements for investigation were required.

Col. King said that he did not think he had misunderstood Major James. It was, he thought, not necessary in each province to send out a man to ascertain where malaria was; this was known. And it was only when the provinces were in difficulties that they would need the assistance of experts.

Captain Christophers then read the following paper. He illustrated some of the points by a reference to diagrams—

A new statistical method of mapping epidemic disease in India, with special reference to the mapping of epidemic Malaria

BY

CAPTAIN S. R. CHRISTOPHERS, I. M. S.

The accuracy and value of mortality statistics in India is often questioned. In the present paper I hope to be able to show that in spite of this frequently expressed doubt as to their value they may be, at least in some cases, an extremely valuable aid in the study of epidemiology, notably in regard to the distribution of epidemic disease.

Obviously the objection as to accuracy is very important and it requires no intimate knowledge of Indian conditions to realise that in greater or less degree the objection is justified by fact.

In regard to the value of the returns there are, however, two distinct questions involved which it is necessary to avoid confusing with each other.

(1) There is the question as to the degree of accuracy with which the mere fact of death is recorded.

(2) There is the question as to the correct diagnosis of the cause of death.

We should not let doubt as to the value of the second of these points influence us in regard to the first, or rely upon the second because we believe the first to be approximately accurate.

It will perhaps clear away some possible misconception regarding any attitude to these figures if I at once confess that, for reasons I shall give later, I have no intention of relying upon diagnosis as entered in the returns and that an error of even so much as 25 per cent in the number of recorded deaths will not seriously interfere with the application of the method of using these returns I am about to describe. Even grosser default in the registration will not altogether prevent the application of this method, though it will no doubt affect the value of the results obtained.

Before going further it is necessary to note very briefly what mortality figures are available and the conditions under which they are collected. In doing so I shall confine myself to a discussion of the returns of the Punjab, which so far are the only ones I have investigated in sufficient detail to enable me to speak.

Two series of mortality figures are collected namely (1) those from towns sufficiently large to possess municipal arrangements and (2) those from rural areas. In the case of towns the registration of deaths is conducted on various lines. For example, in Amritsar deaths are recorded by the return to a Registrar of Births and Deaths of the permits given to persons burying relations in the different cemeteries which surround the city. The system so far as I have been able to judge is conscientiously carried out ; and the fact that the city is so densely populated makes it improbable that many burials take place outside cemeteries. Those who are familiar with the conditions would allow, I believe, only a small error, say 5 per cent, as regards the total number of deaths recorded.

If we can rely upon the figures to this extent we have a very valuable asset in the Amritsar figures in studying the mortality from epidemic malaria, the more so since the particulars regarding age, locality in which the death has taken place, etc., are with the rarest exceptions recorded. In Amritsar unfortunately an immediate use of the statistics as applied to locality is impossible since the areas known as " Divisions ", of which the populations are known, are not separately recorded, whilst the " Katras ", which are the units used, are areas of which the population is unknown. Nevertheless the material facts are all recorded though their application is only possible at the cost of some labour. The value of the results that may be obtained from such figures are evident from some maps of Amritsar I am showing you in which the history of the epidemic malaria of 1908 can be very clearly traced. In Delhi deaths are recorded separately for the different wards and of these the population is known so that the records are available at once to give valuable information even allowing, as we are willing to do, an error of say 25 per cent.

On the contrary in Lahore the particulars of registration do not include the locality in which the death has occurred and the information regarding deaths is useless except as regards the city as a whole. In the smaller cities again some have, so far as one can judge, well maintained systems of registration, others much inferior ones. But we may I think take it for granted that matters are rarely so defective as to entail an error of 25 per cent, an error which we have already stated need not deter us from making use of the figures in the ways I shall indicate.

The second series of returns, namely those from rural areas, are collected in the following way. In each village there is a *chowkidar* whose business it is to record in one book the deaths and in another the births taking place in the village. At various times these books are brought by the *chowkidar* to the Police station of the *thana* in which the village is situated, and all entries are copied out into the general register of deaths kept by the police. At the end of the month the deaths recorded in each thana are totalled and sent to the Civil Surgeon of the district who collects the different *thana* figures in a monthly statement which he forwards to the Sanitary Commissioner. It is these figures totalled for the " Districts " by the Sanitary Commissioner which are published for rural areas.

But Districts are very large units often exhibiting considerable diversity of physical features in their various parts ; they have, often enough, areas in which an epidemic has occurred and others in which there has been no epidemic. The result is that in the total figures epidemic rises tend to be obscured, the more so the larger the area to which the statistics refer, as for example when the figures for a number of districts are grouped together. To show how this comes about we may take, as an example, the returns for Delhi in 1908. If we look to the total figures for the city given week by week we get a curve as shown in the accompanying figure, a curve which shows a somewhat indefinite and not very high rise during the period of epidemic malaria. But if we now deal with the components from which the total figures are obtained, that is the figures for the separate wards of the city, we get in some very high epidemic curves as for example in Ward I, comparable with those of the worst affected areas in the Punjab, whilst in others we see only extremely modified epidemic curves, the wards in this case having, for reasons we need not enter into here, been comparatively free from the epidemic. We see clearly in fact that by the act of including the figures for various areas of different characters in our total we have obscured facts very clearly shown if we study these figures separately.

Again, when we use figures for the whole year we tend to dilute as it were and so either partially or wholly obscure an increased death rate due to epidemics lasting a short time.

By separating the figures into those relating to the different months and into those for the different *thanas* we greatly accentuate any facts shewn by returns.

Leaving for the present therefore any consideration of annual district totals, let us examine with a view to their utilisation, statistics for the *thanas*. The statistics relating to towns we shall not further discuss in this paper, though these are well worthy of study and afford most interesting information in regard to epidemic disease.

The first thing we shall notice in a series of monthly *thana* figures is that in the absence of epidemic disease the number of deaths exhibits a very moderate amount of variation.

It is different the moment epidemic disease makes its presence felt. We then have rises in the line of a very noticeable kind, as for example in the curve given where cholera was epidemic in a *thana* (Nurpur). Turning our attention to such rises in the total death rates we shall find that each rise is associated with the record of some epidemic disease. A further examination shows that there are four diseases commonly concerned in these rises of the total death rate, namely, plague, cholera, small-pox, and malaria ; of these plague and malaria stand consistently pre-eminent. If we further examine numbers of *thana* records we find that the epidemic rise from each of these diseases tends to occupy a certain definite portion of the year. Plague shows a rise, generally in the first half of the year; malaria very consistently causes a rise in the months of September to December ; cholera with considerable uniformity is the cause of any rise in July or August. Small-pox exhibits more impartiality in its distribution throughout the year, but like plague is more often epidemic in the spring than in the autumn. The different diseases also often exhibit very characteristic epidemic curves. Cholera gives a short sharp rise, small-pox a long curve not usually of any great height. Malaria especially gives a very characteristic curve rising sharply to its full height in October, remaining high for November and perhaps December, and falling gradually throughout the early months of the year.

Even if one has no information regarding the disease concerned in the epidemic, it is possible nearly always to make a correct diagnosis from this seasonal occurrence and other features of the curve, just as one may diagnose some disease by means of a temperature chart.

The important point, however, in our present connection is that we are justified *in assigning the increase in deaths during any particular rise to the disease then epidemic*, though of course cases occur where the effect of two diseases overlap or perhaps run concurrently. In the first case we can generally see what is happening ; and the second eventuality is sufficiently rare not to be a serious cause of error.

If we can rely upon the total number of deaths being approximately accurately recorded we can therefore almost afford to neglect the question of correct diagnosis. One is the more satisfied in doing this from the following considerations.

If we take a rise of deaths associated, let us say, with the presence of epidemic plague, we do not find that deaths recorded as due to plague are necessarily sufficient to make up the entire extra mortality that has given us the rise in the curve. A moment's thought will show us what is happening ; it is that many cases really plague or indirectly due to plague are not diagnosed as this disease. In the case of cholera we often find cases recorded from villages near head-quarters are returned as cholera, but those from outlying and remote villages as some other disease ; yet the increase of deaths in both alike justifies us in saying that cholera was the cause of the high mortality in each. The epidemic curve in fact is often a more reliable guide to the mortality from epidemics than the diagnosis given in the death returns. In the accompanying

chart of deaths in Nurpur during the years 1903 to 1906 a small rise is seen. According to the returns this is due to an increased death rate from fevers. From its position we should suspect the rise to be due to cholera and as a matter of fact we find that deaths from cholera at this time are recorded in nearly all the *thanas* of the district. We can safely conclude that though not seriously affected Nurpur suffered to a certain extent from the cholera epidemic.

Again whilst dealing with total death rates we are dealing with actual facts. But once we take note of "diagnosis" we deal with conclusions only, conclusions more or less true or untrue. And it is not only that diagnosis by an ignorant *chowkidar* is apt to lead us astray; but that the diagnosis even of expert medical men may in some cases lead us into error. If we actually investigate conditions, for example, where we know malaria to be causing a heavy mortality, we at once meet with cases that the pathologist perhaps recognises to be primarily malarial but which can quite correctly be returned as dysentery, pneumonia, bronchitis and so on; the ignorant *chowkidar* who returns all as fever in such a case may give a truer picture than the expert clinician who returns us perhaps in many cases the actual cause of death.

It is not necessary then to demand as a first essential to a study of disease by mortality statistics that all deaths should be correctly diagnosed. It is even possible that apart from epidemic disease the effect of different diseases upon the death rate may eventually be better determined in India by the investigation of sample villages and areas and proportionate allowance made in the total figures, than to hope for such an impossible triumph as an invariably correct diagnosis of the cause of death.

Such remarks are especially applicable to malaria, the diagnosis of which is recognised to be in many cases difficult. If we chart out for each month in any given area the number of deaths from "fevers" we shall find that whereas throughout the year in the non-epidemic periods there is an approximately even distribution of deaths under this heading, there is in the autumn the epidemic increase we have already referred to. If we take a number of years we shall see that whilst the deaths returned as "fevers" during the non-epidemic periods keep approximately the same, the death rates of the epidemic periods vary enormously from year to year.

Let us take for example the monthly deaths from fevers in the Shahpur district. We shall see that year by year except during the period of epidemic malaria, the deaths from fevers maintain so constant a figure that they scarcely ever drop below 500 or rise above 700 in the month. Deaths from non-epidemic fevers in this district therefore may be taken to number about 7,000 per annum. The excess in any year over this is demonstrably due to the autumn epidemic of malaria. The extra deaths vary from 1,000 to as many as 20,000.

With these preliminary remarks upon the statistics in general let us turn our attention to methods of utilising these statistics in the mapping out of epidemic disease.

We may summarise our remarks by saying that when an epidemic disease makes its appearance in a *thana* its effects are clearly seen in the form of a rise in the death curve. Examples of such rises are constantly occurring as we follow the death figures of any particular *thana*. If we refer to the figures for surrounding *thanas* we find as a rule these same rises repeated, showing that the *thanas* were all more or less simultaneously affected. But as we pass away from severely affected areas the epidemic curve becomes smaller or may cease to be apparent. An epidemic rise, for instance, such as is shown in the curve for Kot Momon in comparison with such epidemic rises as will be described later, is quite insignificant, but it serves to show how even in its minor manifestations epidemic mortality betrays itself.

In tracing out then the distribution of an epidemic we can note its presence or absence in any particular *thana*. Not only so, but whilst in some *thanas* the height of the epidemic rise shows that the epidemic was severe, in others it tells us that the effects were slight. We can in fact not only map out the extent but also the varying intensity of the epidemic over any area we wish. All we require is a figure to indicate in each case the height of the epidemic

curve. Such a figure may be the death rate per mille during the epidemic time compared with the average death rate in non-epidemic periods. But we may measure the epidemic intensity in an even simpler manner by using what I shall call an epidemic figure. This figure I obtained by dividing the number of deaths during a given period during the height of the epidemic by a figure representing the average number of deaths in a similar period free from any epidemic disease.

In the case of malaria I have made use of deaths during October and an average of five years July deaths, respectively, this latter month being convenient since it is not liable to epidemics of plague or malaria. But in studying the distribution of epidemics we may take the figure for any other month we may wish or use any other standard of average death rates provided we use the same method throughout. As so obtained the figure is simply a ready way of indicating the height of an epidemic rise.

As an example of the use of this figure let us take four *thanas* in the Shahpur district, Bhera, Shahpur, Bhalwal and Kot Momon. Confining our attention to the latter months of the year 1908 we have in Shahpur a rise about five times higher than the normal, in Kot Momon the rise is not more than twice, whilst in Bhalwal it is about three times the normal. In Bhera, however, we see that the epidemic curve rises to at least twenty times the normal.

If we now take other *thanas* in this district and give to each its epidemic figure, which you will remember is simply a figure representing the height of the epidemic rise, we shall find that we are mapping out an epidemic having its greatest intensity in the Bhera *thana* and fading in intensity as we pass to the west and south.

In a similar manner we can apply this method readily to the whole Punjab and we find that instead of vague ideas we get the most definite information regarding the distribution of the 1908 epidemic.

In a similar manner also we can not only map out this epidemic, but we can go back as far as our figures are available and map out epidemic malaria in any year we wish. The peculiarities of the different epidemics which have ravaged the Punjab I shall refer to in another paper; but I may point out how remarkable are the facts brought out in the series of maps I am showing you.

So far we have used *thana* returns. But in dealing with such great and widespread epidemics as those we have described we may use even district returns with advantage. But the results as shown in the accompanying map fail to give us many of the more interesting features of the distribution shown by the *thana* figures, as for example the long tongues of epidemic malaria in 1908 extending down some of the riverain tracts. More interesting are the results obtained from further subdividing the *thana* records.

Although not available except in the village *chowkidar's* books or in the general register in the particular *thana* concerned, we can, if we visit the *thana*, obtain statistics for individual villages. But the number of deaths now being much smaller we cannot treat our figures so rigidly as those relating to the *thanas*. Nevertheless we can obtain very definite evidence regarding the extent to which any particular village suffered and we can map out again in greater detail any particular *thana*.

The accompanying figure gives a plan of Shahpur *thana* worked out in epidemic figures for October 1908. The distribution of malaria shown by this method was found to correspond with remarkable exactness to that indicated by an examination of the spleen rate and other indications as to the effect of the 1908 epidemic. A similar correspondence was shown in Bhera, Bhalwal, Kot Momon, Gujrat and other *thanas*.

By utilising in this way village death returns, one can therefore in a single day map out the distribution of epidemic malaria over an area which it would take weeks to explore thoroughly.

Another use to which this method can be put is to map out the history of an epidemic month by month as I have done in the maps of Amritsar I have shown.

Briefly then I may summarise my paper by saying that the mortality statistics of the Punjab are capable of telling us a great deal regarding the incidence of epidemic disease.

That in arriving at this information the method of using an epidemic figure has its uses.

In the case of great epidemics we can gain a rough notion of their distribution even from applying this method to district totals. But to ascertain with any delicacy the distribution of these epidemics it is necessary, for reasons we have explained, to resort to *thana* figures or even for certain purposes, to the returns of individual villages.

The following discussion ensued :—

Mr. Nathan said he would like to have some definite idea of the manner in which each province was to obtain accurate vital statistics. He took it that they were to find out for each province the relative intensity of malaria in the different parts by the use of the general statistics, and having done so, would require to find out by more detailed investigation what portion was due actually to malaria. Were they to take sample areas in different parts of the province and on what sort of scale in order to correct the figures of the province as a whole ? Then did they require a separate set of investigations for the particular measures required for these malarial areas ?

Mr. Ferard said that a special officer, Major Robertson I. M. S., had been put on in the United Provinces and described what his duties were. The special officer worked in the most malarious part of the province.

Mr. Nathan asked whether the special investigation would have to be on a very large scale and in many places.

The President understood that if it was decided that special investigations were necessary the methods of enquiry indicated by the progress of science up to date showed that expert officers would be required. The officers would be required to work in accordance with the latest methods of research and he presumed selected areas would be taken. He thought it was desirable that the Conference should come to some conclusion on this question and on the question of selected areas ; they were pretty big questions.

Colonel King said that in the first place there was a large amount of local experience to go upon. In respect of statistics anything above a certain rate would arrest the attention of the Sanitary Commissioner and of the Civil Surgeon of the district. Speaking broadly, he thought Captain Christophers' paper represented the difficulties which existed under the present system, and Captain Christophers had brought forward a very ingenious method of dealing with them. The paper represented the results of a resurrection of old statistics. What was now required was living results. If there were in each province an organized sanitary service, would it be necessary to take old statistics and take a rough rate for this and for that ? He thought not. If there were a sanitary service it would be possible to say in certain circumstances what was occurring and the sanitary officers would go to the spot at once and advise. Captain Christophers' paper had shown among other things that registration is defective. He repeated his suggestions as regards the sanitary service.

Colonel Leslie said that Captain Christophers' paper dealt with a method of investigating epidemic malaria in the provinces and one of Major James's proposals was for checking the every day returns of *chowkidars*. The two subjects should be kept distinct. In regard to the proposal for checking existing vital statistics he said that the accuracy of registration varied very much in different parts of India, perhaps it was best in the Punjab and worst in Madras ; what it was necessary to know was how far these *chowkidars'* figures were correct. The causes of death were inaccurately given. Some time ago he made a proposal that certain areas should be selected in each province and there medical men should be sent who would go over the whole of these little areas and enquire into every birth and death, register the actual number of births, still-births, deaths and the causes of death. This had been done in Bengal

If enquiries were carried out carefully it would be possible to get a good idea of what takes place from day to day in the selected areas and the results would form a key by which the statistics of the whole province could be interpreted. In the area of enquiry in Bengal the deaths from fever were given at 65 per cent of the total deaths, but by the enquiry it was found that phthisis, pneumonia, kidney complaints and many other diseases were included under the heading fever. It was calculated that the true deaths from fever were 25 to 35 per cent of the deaths recorded under that heading. It was thus shown that in regard to diagnosis the everyday statistics which the people themselves collect are entirely wrong, and we now desire by special enquiries in each province to obtain some standard figures by which those statistics may be interpreted.

The following paper was then read—

Malaria in the Central Provinces

BY

MAJOR W. H. KENRICK, I.M.S.

The Central Provinces has not suffered from malaria to the same extent as some of the other provinces, the average death rate from "fevers" for the ten years from 1898 to 1907 was 17 per 1,000 of population.

If, as suggested by the Sanitary Commissioner with the Government of India, we should consider 25 per cent of these deaths as due to malaria, it means that about 51,000 persons annually die of this disease in the Central Provinces.

Since 1897, when the fever mortality reached 40·9 per 1,000, malaria has not assumed an epidemic form. Although there was some increase in 1908, there was nothing approaching the severe epidemic experienced in the Northern Provinces.

The varieties of fever most commonly met with are the benign tertian and the malignant tertian forms. It is noteworthy that the latter type is more often met with in association with forests and low-lying land near jungle hills, and as a very large portion of the Central Provinces is reserved forest, much of the malaria met with is characterized by fever of a remittent nature with a tendency to relapses, and chronic enlargement of the spleen.

Typical cases of benign tertian are met with more especially in Europeans and susceptible new-comers to the country, but with natives of the province the malignant tertian is the variety that most frequently comes to notice.

In the jails and police hospitals most of the cases of malaria are relapse cases. The jail statistics, however, are occasionally misleading by the inclusion of many cases of "Spirochaete fever" under the heading of malaria; it is only by the diligent microscopical search of a blood specimen that these can be differentiated with any certainty.

The great majority of malaria cases, especially those of a severe or persistent type of fever, give a history of having acquired the infection while in the district away from the head-quarter town.

A European is called upon to leave his head-quarters on a short tour of duty; he spends a few nights in a certain dak bungalow or rest-house, and within three weeks of his return he develops an attack of fever. With natives it is generally the result of stopping the night at some "*parao*" or rest camp, or at some village *dharmsala*, while on a journey to or from his home. This is the usual cause of the attack of malaria; very few cases are of indigenous infection.

A continual importation of malaria takes place from the highly infected rest-camps and halting-places on the main lines of traffic into the head-quarter towns.

There is always a certain amount of malaria of local origin in most towns, but this affects mainly children and new-comers: it is probable that adults sometimes acquire a certain measure of immunity to] local infection, but are not

immune to the more virulent type found at certain places in the interior of the districts. As is the case elsewhere the infection readily yields to treatment, if thorough.

For simple cases of benign tertian and mild attacks of malignant tertian a purge, followed by 15 grains of quinine, in solution, twice a day, for five or six days, suffices.

For the severer forms, especially cases of remittent fever in natives, who often object to single large doses of quinine, I have found a dose of 2 grains, every hour during the day and occasionally at night if necessary, most efficacious.

By this means the dose can be regulated to a nicety, the administration being withheld so long as symptoms of cinchonism persist.

A high remittent fever which has lasted some time will often readily yield within 48 hours to this treatment.

With regard to the hypodermic administration of quinine (intra-muscular rather than subcutaneous) for pernicious attacks, I have found no ill-effects resulting from the bihydrochloride salt. On the other hand, upon two occasions the use of the bisulphate salt has been followed by a small circumscribed slough.

For malarial cacchexia and chronic fever, quinine should be supplemented by large doses of Epsom salts, the latter having a marked action in setting free the parasites in the blood stream, and thereby bringing them under the influence of the quinine, and also in quickly reducing an enlarged spleen.

A dose of Epsom salts often brings on an attack of fever in a person, who imagines he has long been cured of the disease, and is thus often an aid to the diagnosis of chronic malaria.

As regards prophylaxis, anti-mosquito measures have during the last few years been systematically carried out in several district head-quarter towns of the Central Provinces. These comprised the employment from June to December, under the supervision of the civil surgeon, of a gang of specially trained men, in filling in borrow pits, drawing off or paraffining collections of water, clearing the channels of *nullas* and ditches, draining off the overflow water round wells, and in cutting down and eradicating rank vegetation within municipal limits.

In the Betul district during the past year, there has been a large deduction in the number of malaria cases treated at the main dispensary, but in the other districts the effect of these measures has been doubtful, so far as regards a diminution of the fever cases. The records of the local dispensaries show no decrease in the number of cases treated, and the mortality returns of the towns in question show no reduction in the number of deaths attributed to fever.

However, during the five years these operations have been in progress, there has been no great increase in malaria, and these measures, apart from their general sanitary utility, may have prevented the disease assuming epidemic proportions at times.

As the general application of these measures would be prohibitive in cost, their practical introduction should be limited to cases from which the best results might be anticipated. Such cases, in my opinion, are not those of municipalities and cantonments which as is well known are less malarious than rural circles, but those of "*paraos*," halting-camps, and large junctions on main lines of traffic. Such places form a perpetual source of malarial infection. Persons under the necessity of halting at them do so under conditions most favourable to the mosquito.

The spread of sleeping sickness in Africa is known to be brought about by the localised infection of camping-grounds and "*paraos*."

It is in such places that efforts should first be directed towards the destruction of the mosquito.

To give an illustration. At Pachmarhi, the admission rate of European troops for intermittent fever in 1907 was 654 per 1,000, while the rates at Saugor, Jubbulpore and Kamptee were 286, 161 and 149 respectively.

Natives also suffer severely from malaria in Pachmarhi, while European officers and ladies are comparatively free from the disease.

The reason for this is that the soldiers and nearly all the natives break their journey at the foot of the hill, at a place called Singanama, which is teeming with mosquitos and exceedingly malarious.

The inhabitants of Singanama, and the neighbouring forest villages, suffer to a large extent from chronic malaria and enlarged spleens; they live under conditions most favourable to the "factor of residual infection." The mosquito finds unlimited breeding grounds, and a constant supply of food, thus every opportunity exists for persons halting for a few hours after sunset in the "*parao*" to acquire the infection. They get an attack of malarial fever within two or three weeks subsequently, and accuse the hill station of being malarious.

The carrying out of larvicidal operations at Pachmarhi would thus be of very little use, so long as the source of the malaria is left untouched. This is but a solitary instance of a condition of things prevailing throughout the province.

In the Chhattisgarh division, for example, on all the main roads, there are long series of "*paraos*" used as halting-places for cart and other traffic, bringing in forest and other produce to the railways. Most of these "*paraos*," which are on the banks of a *nulla* or tank, and adjacent to some village, are exceedingly malarious. The annual sanitary reports of the Government of India show that it is not the towns and cantonments that are so subject to malaria as the districts.

It is easy for Europeans to keep more or less free of the disease by personal prophylaxis, *e.g.*, mosquito nets and quinine.

The disease can also be kept down in jails and other large institutions, even in times of epidemic, by the regular issue of quinine, as is proved more particularly by the Punjab Jail Report for 1908. But in the districts the issue of quinine can only be partially successful; it has been tried for many years, but the sale of the packet shows no increase.

Without, however, relaxing our efforts to popularise quinine, material progress in diminishing the prevalence of the disease might be made by systematic larvicidal operations on "*paraos*," rest-camps, and other halting-places on main lines of traffic.

Natives are continually on the move, attending marriage ceremonies, fairs or courts, and performing pilgrimages, and the commonest explanation met with, as to the cause of an attack of fever, is that it was brought on by some journey or other.

In each district a list of the more unhealthy "*paraos*" could be maintained and operations could be commenced upon each in turn, with a view to—

(1) destroy mosquitoes and larvæ, and get rid of their breading grounds,

(2) render the wells mosquito-proof,

(3) issue quinine free to the local inhabitants and to place it at all times within their reach free of cost.

These operations should result in lessening the infectivity of such places, not only for malaria, but to a certain extent for cholera also, and thus tend to bring about a reduction in the prevalence of malaria throughout the district.

The following discussion ensued:

Major Rogers.—I propose to give an account of the investigations which have been carried out in Bengal for some years past. Firstly, I will deal with

the enquiry regarding the Bogra district in 1901 and the effect of the silting up of the river on health. The main feature brought out was the intimate relationship between the high ground water-level and the high malaria rate. One village situated on high ground had a spleen rate of only 10 per cent against an average rate of about 50 per cent, while another village on a high bank of a river and where the ground water-level was low had only 6 per cent. of spleen. The higher part of the district which was the most dry was the healthier part. In the next enquiry in the Dinajpur district in 1904, an effort was made to ascertain the real cause of the deaths returned under the head of fever which ran into over 90 per cent of the total. The result roughly was that only one-third of these were really due to malaria, another third due to febrile conditions such as pneumonia and phthisis, and the remainder to a variety of causes including cholera and small-pox. Further intimate relationship was again found between the high water-level and the high malarial rate while the difference in the death rates in the different parts of the district was due almost entirely to the greater prevalence of malaria in unhealthy areas, the other diseases being fairly uniformly distributed. The next report of the Drainage Committee of 1907 gives records of an enquiry by Captains Proctor and Stewart regarding the districts of Jessore, Nadia and Murshidabad. The ground water-level of this area was so high that at the end of the rains it was only 3 to 4 feet from the surface. They enquired into the causes of the deaths returned under "fever" and obtained very similar results to those in the Dinajpur enquiry; 36 per cent of the fever deaths being due to malaria. They also found that villages on the banks of live rivers with a good current and on high land and dry soil had a spleen rate of 45 to 46 per cent, while those on silted up rivers had a rate of 62 to 64 per cent. This is also in accordance with the ground water-level; it would be higher in the latter than in the former. Further, villages in which the ground water-level was less than 6 feet down had a spleen rate of 75 per cent and in those with a ground water-level over 6 feet down the rate was 55 per cent. Another important point they ascertained was that villages surrounded by dense jungle had a spleen rate of 71·7, those with little or a moderate amount of jungle only 44·5. This may also be connected with the high ground water-level favouring the growth of dense jungle. They also noticed that pools of water were found in the jungle which were protected by it from drying up. In one *thana* of the Nadia district they found sporadic *kala azar* so prevalent that 16 per cent of the deaths were due to it; but in the other areas examined the rate was only 2·4 per cent and so not sufficient to invalidate the value of the spleen test for malaria. The next report is that of Captain Forster the principal point in which is that in the Murshidabad district, which he investigated, sporadic *kala azar* was very widespread; so much so that there was no direct relationship between the spleen rate and the endemic index for malaria. The presence of this sporadic *kala azar* greatly complicates the problem in lower Bengal. Another point which I wish to raise is the importance of the relationship of meteorological data to the prevalence of malaria. Thus in the Chhota Nagpur district of Bengal, excessive rain is followed by excessive fever, while in the Eastern Bengal districts north of the Ganges the opposite is the case, the cause being that that area is under water during the rains, and if the rainy season is prolonged, during the year and the period at the end of the rains is short before the minimum temperature falls below 60° when the development in the mosquito ceases. If, on the other hand, the rains are short there is a long dry period and intense malaria. A closer study of such data in different parts of India for a number of years should enable such epidemics as that in the Punjab last year to be foreseen and give time to take measures against them. With regard to the statistical data required for Captain Christophers' method, I think it is very important that the vital statistics of smaller areas in the *thana* should be recorded in the offices of the Sanitary Commissioners. This would enable this method to be utilized.

President.—It has always been said in Bengal for the last 30 or 40 years that malaria there is mainly due to obstructed drainage silted up by these dead rivers and that the silting up of dead rivers was due to railways.

Major Rogers.—My first investigation of the prevalence of malaria on the banks of the Hooghly was by taking the ground water-levels on each side of the Eastern Bengal State Railway for a distance of 25 miles. The highest

ground is the bank of the river Hooghly. If the railway was obstructing the drainage it is obvious that the water level would be higher on the river side. But there was no difference between the two sides at all. That is the only example I have been able to work out thoroughly and there was certainly no evidence whatever as regards obstruction by this railway.

President.—Then your conclusion is that the railway had nothing to do with it?

Major Rogers.—The railway had nothing to do with it. It was very much more unhealthy on the east of the Railway than on the west, whereas if the railway obstructed drainage the west side would be the worst.

President.—You also spoke about the change of levels.

Major Rogers went on to explain that three different conditions prevail in the 24-Parganas, the Sunderband area which was practically flooded was the most healthy part of the district; the northern end, where the land was raised by silting was more healthy than the intermediate part; the intermediate part where the process of silting was going on and where it was not above flood level, is flooded during the rains and there results a process of drying up. This is the most unhealthy part. He considered this very important as there were costly schemes of drainage under consideration. The result of such schemes might be the turning of a healthy locality into an unhealthy one. The matter required very careful consideration.

President.—Are these being done under the Sanitary Drainage Act?

Major Rogers.—Yes. He then proceeded to say that the drainage scheme in the south of Calcutta which is now being carried out is being very carefully watched, and he was very strongly of opinion that such sorts of drainage scheme should not be carried any further until the result of the present one was known. He touched on the Subramania scheme which he thought might do more harm than good.

President.—It comes to this then that you consider that it is not certain that these large drainage schemes would do any good at all?

Major Rogers thought the contrary and expressed his opinion that they would possibly do more harm than good.

Major Donovan next referred to the question of the distribution of malaria in the Madras Presidency and illustrated his remarks by means of a map based on Colonel King's investigations carried out in 1902. He said that the figures could not be very accurate but would show the malarious districts in Madras. His information was based on cases admitted into the General Hospital and from the returns in the office of the Sanitary Commissioner for Madras. From the investigations made by the Royal Society's Malaria Commission it would appear that the most malarious portions were at the foot of the hills. There were a few other places where malaria was scattered and might be described as artificial and not indigenous malaria. There was also lying along the eastern slope of the Western Ghauts a portion under the same conditions as in the Jeypore hill tracts, but in Malabar and South Canara the conditions as regards malaria were identical with those at the foot of the hills. He suggested that investigation should be made in certain tracts.

Colonel Dyson said that in the Bombay Presidency there were fairly definite areas, including Sind, which were recognised as malarial. The Sind tracts comprise territory which was rendered malarious by the overflow of the Indus river at certain times of the year. In northern Gujarat there were tracts of forest country presenting a different condition of affairs. In still other parts the rice-growing tracts of Gujarat are malarious, and still further south one of the most generally recognized malarial tracts in the Presidency (in Canara district) is a forest tract. Contrary to what the last speaker just mentioned, the usually recognised malarial districts are not actually at the foot of the Ghauts but above the Ghauts. So as regards the Bombay Presidency there were certain definite tracts—possibly half a dozen—over which investigations would no doubt bring about good results. Major James had prefaced his remarks by saying that such investigations should

precede any further measures to be taken, but no doubt they would hear later on in these discussions that there were certain measures which might go together with these investigations in the regularly recognised malarious tracts, and there seemed no reason why anti-malarial measures should not go on while these preliminary investigations were being made.

The President then submitted for criticism a draft which he had prepared formulating the result of the day's discussion. Various verbal amendments were suggested which after discussion were either accepted or rejected and the draft finally passed.

THIRD DAY.

Thursday, October 14, 1909.

PRESENT.

Sir Harold Stuart, K.C.V.O., C.S.I., I.C.S., *President.*

Mr. L. M. Jacob, C.S.I., Secretary, Government of India, Public Works Department.

The Delegates.

The President.—Gentlemen, yesterday the Conference discussed the question of the distribution of malaria; today the first subject put down for discussion is the epidemiology and endemiology of the disease—why, for instance, we have a death-rate from fever of only 7 or 8 per mille in Burma and Madras and of more than 20 per mille in the Frontier Province and the United Provinces, and why some provinces are visited from time to time by intensely severe epidemics while in other provinces such epidemics occur very rarely, if ever. Captain Christophers has written an interesting paper dealing with the epidemiology of malaria in the Punjab, which I shall now call upon him to read.

The following paper was then read, the points dealt with being illustrated by means of a series of coloured maps and diagrams.

On Malaria in the Punjab

BY

CAPTAIN S. R. CHRISTOPHERS, I.M.S.

SYNOPSIS OF CONTENTS.

I.—THE MANIFESTATIONS OF MALARIA IN THE PUNJAB.

The manifestations of malaria in the Punjab present some special features contrasting very strongly in some respects with those exhibited by the disease in moister and more tropical countries.

Though the Punjab in the summer months is one of the hottest regions in India it enjoys during the winter months a quite temperate climate. And as during these cold months and the very hot weather following them it also receives but little rain, it is not until June, when the monsoon sets in, that the conditions become favourable to the breeding of anopheles. Whether or not from this cause malaria remains in abeyance in the Punjab until the autumn months, when in greater or less degree it becomes prevalent. From time to time this autumn prevalence becomes exaggerated and the year is recorded as a bad fever year. But in 1908 this autumn malaria was so severe and was accompanied by so terrible a mortality that it roused general apprehension. As a result it has been my privilege to investigate the conditions associated with this malaria of the Punjab. My researches show an epidemiological picture so peculiar and interesting that I make no apology for bringing my observations before this Conference.

Before going into the general question of malaria in the Punjab some mention is required of the 1908 epidemic.

This epidemic made its appearance about the end of September and involved almost the whole of the Punjab. In parts most severely affected the epidemic is stated to have prostrated the entire population. In Amritsar, for example, for many weeks the ordinary business of the city was interrupted, labour could not

be obtained, transport was disorganised, and even food vendors ceased to carry on their trade.

The effects of the epidemic can best be gauged by a study of the admission rates for fevers in the dispensaries and from the mortality returns.

The extreme suddenness of the outbreak is shown in all records whether of sickness or death as will be apparent from the charts* which I now show illustrating the admissions for fevers and the death-rates in several towns during 1908. A remarkable feature is the almost simultaneous onset of the epidemic throughout the Punjab. With the exception of the extreme south-east, where the characteristic rise from mortality took place about a fortnight earlier than in the northern part of the Punjab, places even hundreds of miles apart were affected simultaneously.

Another peculiar feature was that the increase in admissions to dispensaries for fever only very slightly preceded the increase in general mortality showing that deaths were not the result of protracted sickness but apparently of the intensity of the infection. This is borne out by accounts of Civil Surgeons and others who describe in Amritsar and elsewhere a great prevalence of pernicious cases, especially forms associated with fatal dysentery.

Still another peculiarity is that the mortality curve for almost any severely affected town or area shows the same features, namely, a sharp rise in the beginning of October, a high level maintained throughout October and November, and rates falling rapidly in December and January to normal. The dispensary returns show the same sharp rise but a more prolonged effect, as will be evident from the curve showing admissions to Bhera dispensary. In this latter case the slow return to normal seems in most cases to have been mainly due to persons coming for treatment of enlargement of the spleen, rather than for fever.

During the two months of October and November the number of deaths recorded in the Punjab as due to fever was 307,316 as against less than 70,000 in both 1904 and 1905 and less than 100,000 in 1907.

Studied in more detail the ravages of the epidemic in those areas where it was most intense are even more apparent. In Amritsar the mortality for many weeks was at the rate of over 200 per mille. In Palwal mortality rose to 420 per mille and in Bhera to 493 per mille. Curiously enough in Delhi, a notoriously malarious town, the death-rate rose to only 149 per mille. But a closer examination of the statistics shows that parts of this town were much more seriously affected than one would judge to be the case from the statistics for the whole city ; in Ward I, for example, the mortality rose to over 300 per mille.

The death returns of Amritsar show that the densely crowded outer portions of the city were mainly affected. Again in these the mortality was much higher than the figures for the whole city would indicate. In division IX for example with a population of 17,206 the death-rate rose to 534 per mille and for six weeks was over 400 per mille.

In the district returns, with the exception of those relating to the Gurgaon district which show among a population of 687,199 a death-rate of 267 per mille, the mortality rates are not so high as those given for the towns. This might be taken as showing that the mortality was greater in towns than in rural areas, but a study of returns from individual *thanas* and villages modifies this conclusion, both *thanas* and villages frequently showing mortality rates during October and November of 300, 400 or even 500 per mille.

A peculiar feature of the mortality was the heavy toll that it levied upon infants. The curve compiled from deaths in Amritsar shows very clearly the age distribution of the mortality.

Only one other disease, plague, causes such frightful mortality and one often hears doubts expressed as to whether some other disease than malaria was not concerned in this epidemic of so-called fever in 1908.

But there cannot be any doubt as to the true nature of the epidemic. It exhibited the well known incidence of malaria in the Punjab, corresponding exactly with the seasonal incidence of this disease and of the prevalence of malarial parasites as shown by the observations of Dr. Stephens, Major James and myself

* Not printed.

among the natives of Mian Mir and by the prevalence of parasites in European soldiers in cantonments. It attacked especially the infants, a well known peculiarity of malaria; and it was accompanied everywhere by an increase in dispensary admissions for what was clinically malaria; it was also followed everywhere by a notable increase in the numbers of people suffering from splenic enlargement.

Examination shortly after the epidemic of areas especially affected showed in every instance a remarkable condition of almost universal infection with malaria. In Palwal and the affected areas of Amritsar almost every child had splenic enlargement and malarial parasites in the blood. In Bhera and in the villages of the Bhera *thana* the same condition prevailed.

In Amritsar the distribution of enlarged spleens and of parasites tallied exactly with that of the mortality as will be seen from the sketch maps which I now show. In those areas where the epidemic was absent or exhibited itself mildly, as Katra Chauk Pasian, few or none of the children had enlarged spleens; where it was transient, as in parts of Katra Allowalian, one found children with spleens but slightly enlarged or just palpable; where the epidemic was especially severe, as in Katras Khazana and Ramgurian, not only had almost every child parasites in the blood, but the spleens were notably larger and more tumid than usual; from 25 to 50 per cent of the adults were also affected.

In the rural areas the same relation of mortality to malarial conditions held good; wherever a village had been severely visited by mortality the inhabitants, and especially the children, showed profoundly the effects of malaria. Outside the epidemic area things were very different and the number of children with enlarged spleens after did not exceed 25 per cent. The tumid spleen so characteristic of places severely visited by the epidemic was also much less frequently seen outside the affected areas.

The Distribution of the Epidemic.

As regards distribution the epidemic affected to some extent almost the whole Punjab. In the towns a rise in deaths in the months of October and November was almost universal. Almost all the districts also show some increase in the death-rates during the autumn.

If we colour a map of the Punjab according to these district figures we get a result as shown.

A more detailed and much more instructive picture of the distribution of the mortality is that obtained by the method of using *thana* figures which I have described in another paper read at this Conference.

Mapping out the 1908 epidemic in this way we get the results illustrated on this map.

There are many points worthy of notice. It is clear that the malaria of 1908 occurred in the form of two epidemics, one in the north involving Gujrat, Gujranwala and Shahpur, and one in the south-east involving Gurgaon, Delhi and parts of Rohtak. Other epidemic areas are shown, notably one over Ludhiana and part of Jullundur; but in comparison with the two large areas noted these are small in area and low in intensity. This distribution tells us much concerning the malaria of the Punjab we did not previously know.

In the first place it is important that such definite epidemic areas can be mapped out at all. Had the malaria of 1908 depended merely upon local causes, the number of pools about a village and so on, we should have expected to obtain a map covered with confused figures indicating haphazard variations as the intensity of the disease rose or fell from *thana* to *thana*. There would be no reason why several affected *thanas* should form as it were a nucleus to epidemic areas or that the intensity of the disease should show a more or less regular decline as we pass outwards from these foci.

The map shows us conclusively that there is some general determining factor over and above local conditions which acts over these epidemic areas and with increasing intensity as we approach their focus.

It shows also many other interesting facts. A very notable feature, especially of the northern epidemic, is the occurrence of certain tongues of epidemic

which tend to follow in the line of different riverain tracts, one along the Jhelum, one over the Chenab, another over the Ravi, and some isolated spots over the Sutlej riverain.

But what I wish most to emphasize at present is the peculiar character of the areas of special intensity which are shown in the centres of the epidemic. In the southern epidemic for instance we see an area extending over much of the Gurgaon district in which every *thana* had a death-rate of over seven times the normal. In the centre of this tract are *thanas* showing death-rates during the epidemic from ten to as much as seventeen times the normal. In the *thana* of Nuh, for example, where normally there are about 125 deaths in the month, there occurred in October 1908 no less than 1,404 deaths. In the *thana* of Hodal which normally has about 100 deaths there occurred in October 1,083; in the *thana* of Ferozepore with a normal of 130 deaths per month there occurred 2,346 deaths.

In the northern epidemic there is the *thana* of Gujrat with ten times its normal death-rate and villages showing in some cases a mortality as much as 30 and even 50 times the normal.

In the special focus shown at Bhera there are scarcely any villages showing a death-rate below 200 per mille, whilst the majority range between 200 and 500, and one shows the extraordinary figure of 641 per mille.

If it were not for Bhera town itself which shows an equally high mortality rate we should hesitate to credit these extraordinary values. Yet if there be errors of registration they must err on the side of under-estimating rather than over-estimating the mortality.

If we refer to the figures for the small towns we shall see that it is those towns situated in areas of special intensity which have suffered so severely in the epidemic of 1908. Palwal and Bhera we have referred to, but there are others not mentioned in the published returns equally profoundly affected, as for instance Hodal which in October had a mortality rate of 554 per mille.

One feature then of the epidemics is the occurrence at certain central portions of the epidemic areas, of foci so profoundly affected that we can scarcely credit the figures we are dealing with. It is the effect of malaria of this kind which has caused such alarm and apprehension, for though it is recognised that fever was bad generally throughout the Punjab it is the conditions in Amritsar, Gujrat, Palwal, and Bhera that one hears cited as showing how terribly the people suffered in this epidemic, and this statement is further borne out if we examine the distribution of deaths, for taking the comparatively small area in which *thanas* show over seven times the non-epidemic death-rate we shall find that instead of the deaths in October numbering 6,841, which is an average non-epidemic rate for these *thanas*, they number 76,256 leaving only about 100,000 deaths for the whole of the rest of the Punjab. Tracts affected in this way by malaria I have for convenience termed "fulminant areas".

We might describe the year 1908 by saying that there were two main epidemic areas, one in the north with fulminant areas over Gujrat, Amritsar and Bhera, respectively, and one in the south with a fulminant area over Gurgaon. The relation of these fulminant areas to the general malaria of the Punjab may be realised from the diagram which I now show.

If we judge from remarks about the 1908 epidemic we may be led to think that in this year some special new conditions were introduced which have accounted for the virulency of the disease. Let us see how far such an idea is tenable.

Previous Epidemics.

Wishing to map out malaria for past years as I have done for 1908, I was much gratified to find that the necessary information was available in the Sanitary Commissioner's office and from the records very kindly placed at my disposal by the Sanitary Commissioner of the Punjab, I have been able to map out malaria in years in which fevers were especially prevalent as far back as the seventies.

If for reasons I have given in a previous paper, we compare the total deaths in the Punjab during October and November for different years we shall be able to pick out years in which the autumn deaths showed a great increase (*vide* diagram). If we map out malaria in the years thus indicated we shall find that each year of heavy autumn mortality has been one in which the Punjab has been visited by an epidemic and that these epidemics like those of 1908 are localised to certain tracts, have fulminant areas, and exhibit the other characters which I have pointed out in the epidemics of last year.

The maps so prepared I am exhibiting to-day; they are I venture to say of extreme interest. Unfortunately in the space at my disposal it is necessary to confine myself to a very brief notice of the features they exhibit.

The years specially noticeable for a high autumn death rate are 1908, 1900, 1894, 1892, 1890, 1884, 1897, 1878, 1876, and 1869.

In 1900 there was a large epidemic over Ludhiana, Umballa and Karnal. In the heart of this epidemic is a fulminant area as great in extent as any such area in 1908. To the north over Gurdaspur and Sialkot is another smaller epidemic area with a fulminant area over the valley of the Ravi. In the south of the Lahore district we see also a small fulminant area over the Sutlej riverain. The deaths in the autumn of this year numbered 254,580 as against 307,316 in 1908. Therefore even so late as 1900 we have a condition very similar to and a mortality not very far short of that in 1908.

In 1894 there is a single epidemic area over Gurdaspur, Amritsar, Jullunder and part of Sialkot and Hoshiarpur with a small fulminant spot to the north of the Amritsar district and one near Jullundur. The lighter green shows areas bearing an epidemic figure over 2 and 3 respectively. The epidemic shows a "contour" effect that is very remarkable. The deaths in this year for October and November numbered 132,767.

In 1892 there is again a single epidemic area but of enormous size. This year in fact is one remembered as the great fever year. But in spite of the enormous fulminant area extending over several whole districts, there was in the southern Punjab no trace of an epidemic, the death rates indeed for most of the *thanas* in Gurgaon, Delhi, Karnal and Rohtak were not raised above their non-epidemic rates. In this epidemic there is a small isolated fulminant area over Bhera as in 1908. The epidemic distribution also exhibits very strikingly the long tongues of raised mortality we have previously referred to as characteristic of the 1908 epidemic. The deaths in this year numbered 283,223 or only slightly less than the number in 1908.

In 1890 we have an extraordinarily compact epidemic, again with a large fulminant area mainly over Gujrat, Sialkot and Gujranwala, characterised by terrible mortality rates, Wazirabad having an epidemic figure of 28, Sialkot of 26, and Gujrat of 24. In this year the deaths numbered 246,487 in spite of the fact that the whole southern portion of the Eastern Punjab was unaffected.

In 1884 we have an epidemic area somewhat in the same position as that of 1900, namely over Ludhiana and Umballa with a fulminant area also characterised by very high figures. Machiwawa showing 30 times the normal death rate whilst several *thanas* are 18 and 19 times the normal. There are also three curious small isolated fulminant areas, one in the low-lying area of Tanda Urmar, one near Delhi, and one in the Sutlej riverain near Ferozepore. A peculiar tongue of the epidemic is seen lying along the Jumna riverain in the Karnal district.

In 1879, a notorious fever year, we see how localised was the epidemic and the enormous extent of the fulminant area. In this year the autumn deaths were 142,006 in spite of the fact that registration of deaths at this time was evidently much less complete than at present. The whole of the northern area was practically untouched by the disease.

In 1878 we have a very peculiar epidemic affecting Jullunder, Hoshiarpur and Ferozepore. The main fulminant area lay over the Sutlej riverain. Some tongue-like areas of epidemic are seen in the Jhelum, Chenab and Ravi riverains.

In 1876 there was a peculiar epidemic lying close up to the hills involving Hoshiarpur and Gurdaspur.

Of the 1869 epidemic I have not been able to get any detailed information.

Thus each year of heavy fever mortality is one of epidemic conditions affecting severely as a rule only a comparatively small portion of the Punjab. Judged by their distribution three types of epidemics can be distinguished—

(1) Epidemics occurring in the north of the submontane and central tract.

(2) Those about Umballa and Ludhiana.

(3) Those in the south-east of the Punjab.

Out of the nine epidemics five, namely those of 1908, 1894, 1892, 1890 and 1876, are northern in type. Three, 1900, 1884 and 1878, are central, and two, those of 1908 and 1879, eastern in type.

Even in years not so tremendously characterised by mortality we shall find that the autumn fevers exhibit the same tendency to localisation, but being smaller in degree and insignificant in area, such epidemics do not influence the general statistics as do the great ones we have just described.

For want of time I have attempted to trace out a few recent years only; 1906 is an example of a year with small epidemics of the central type; 1903 also shows incipient epidemic areas; 1904 was practically free from any epidemic and it is noticeable that the deaths for October and November are not above the normal non-epidemic rate of about 30,000 per mensem.

The conditions in the year 1908 were therefore in no way new to the Punjab. Even as regards gross mortality it was but slightly more severe than the epidemic of 1892, and as regards its fulminant areas they were neither so extensive nor so severe as those of some previous years.

We cannot then plead that the conditions of 1908 were so very exceptional. We may expect something approaching them any year. We can be certain that in the future many such epidemics will visit the Punjab. Let us see so far as we can the general effect of this recurring fever mortality.

The total death rate in the whole Punjab from non-epidemic fevers is in round figures about 30,000 per month. In a year we should get 360,000 deaths from non-epidemic fever. In this category are included such diseases as tuberculosis and many others. It practically represents the residue of deaths from all causes after abstracting a certain number of deaths for plague, small-pox, dysentery, etc.

In 1908 an equal number of deaths occurred in two months from epidemic malaria alone. In the Gurgaon district which normally loses from non-epidemic disease about 17,508 persons in the year, there occurred in the month of October 1908 no less than 15,740 deaths or nearly as many people as would have died in a whole year from non-epidemic disease. Sialkot which normally loses about 3,000 a month from non-epidemic disease, lost in October 1890, 33,609 persons and in October 1892, 20,972. Gurdaspur which normally loses about 2,000 a month, lost in October 1890, 11,976, in October 1892, 18,921 and in October 1894, 10,551 persons. Umballa which normally loses about 1,500 a month, lost in October 1890, 17,025 persons.

If such conditions are repeated several times in a decade it is not wonderful that we should see the effects when the decennial census is made.

In these epidemics we see in fact the instrument by which malaria attacks the Punjab. Endemic malaria certainly exists but it is the mortality from the epidemic disease which gives to malaria in the Punjab such prominence.

II.—Factors involved in the Epidemic Malaria of the Punjab.

That in the Punjab a bad malarial year follows upon an excessive monsoon rainfall is a common belief; on the other hand attempts to show a close relation between rainfall and malaria have not been very successful.

In order definitely to decide this important point I have studied in some detail the question of the distribution of epidemic malaria in relation to rainfall in the Punjab.

Rainfall.

In 1903 the rainfall in the early months of the year was below the normal and its distribution shows no relation to the epidemic areas. Unusually heavy rain in the early months is therefore not necessary for epidemic conditions.

Again, at Palwal the heaviest rain fell chiefly in the early part of the monsoon; at Bhera the heavy and unusual rain which flooded the area fell very late in September. Many other instances of a like kind could be given. The exact distribution of the rain in the monsoon does not then seem of great importance.

We may commence therefore by a consideration of the relation between the total monsoon rain and epidemic malaria. If we put side by side deaths from fever in October and November and the average rainfall for the Punjab, we see roughly that in many cases the bad malarial years were associated with a heavy monsoon but we have several instances where not only has heavy rain occurred without a heavy mortality, but there have been fever years with a by no means excessive rainfall. This will be clear from this chart which has been adopted from the census for 1891. This method is, however, at the best a clumsy one and liable to lead one to false conclusions. A much more delicate method can be employed. There are in the Punjab some 30 recording stations for rainfall and records for these dating back to 1884 have been kindly placed at my disposal by the Director-General of Agriculture. From these it is possible to plot out upon a map the different amount of rain falling at these stations in any year. If we do this we get instead of an unintelligible mass of figures a clear picture of the rainfall conditions. The method has the advantage of enormously simplifying comparison of rainfall and malaria.

The epidemic maps for different years I have already exhibited. With these we may compare those showing the distribution of rainfall. We see at once that the general position of the epidemic areas is determined by the rainfall. When heavy rainfall is widespread malaria tends to follow its distribution. Not only so but the fulminant areas are always associated with the areas of greatest precipitation.

When rainfall is excessive we get large and intense epidemic areas, in years of small rainfall epidemic areas, if they exist, are smaller and less intense, as for example in 1907. Nevertheless we can clearly see that there are other factors determining the exact distribution and intensity of epidemics.

The boundaries of the areas are in the first place rarely exactly marked out by the distribution of the rainfall. The epidemic tongues, for example, are features apparently apart from the distribution of rain. The extent of the epidemic also bears no definite and constant relation to the amount of rain. For example in 1894 very heavy and widespread rain fell but the epidemic was localised to those areas which received very excessive rain indeed and then it was not very intense. In 1906 again there was heavy rain with little fever. In 1901 with a much less rainfall fever was more general than in 1894 though there was no large epidemic. In 1892 the rainfall was not so excessive as would be imagined from the extent of epidemic malaria.

Though then rainfall determines the area affected, and to a large extent the general characters and intensity of the epidemic, its effects are modified by some other factors.

Physical features.

In the 1908 epidemic the specially affected areas were in the neighbourhood of Palwal, Hodal, Ferozepore, in Amritsar city, Gujrat and Bhera.

The Gurgaon area is part of the riverain of the Jumna which here forms a broad plain with a slight slope towards the foot of the hills which lie behind Nuh. As a result of this conformation and the impervious character of the silt of which the plain is formed heavy rain results in large tracts being more or less inundated.

Palwal and the other affected towns were in fact as a result of heavy rains in 1908 surrounded by water which lay for several months before it eventually dried up; and in February some of the villages of this district were still almost surrounded by water. The subsoil water at the time of my visit was not infrequently found almost at the surface and throughout the affected area it was rarely at a depth of more than five or six feet.

Amritsar lies in a shallow depressed area in one of the lines of drainage of the Bari Doab. It is normally surrounded by many sheets of water and the conditions are such that ordinary rain results in innumerable pools. Nevertheless it has only three times been visited by severe fulminant malaria, namely in 1876 when deaths in October numbered 2,430, in 1881 when deaths in October numbered 5,582, and in 1908 when deaths in October numbered about 4,000. The special feature of 1908 and other fulminant years was "flooding."

Bhera lies in the Jhelum riverain where this forms a broad plain only slightly above river level. The whole area as a result of heavy rain was more or less flooded. Bhera itself was so surrounded by water that it is stated that one could have gone round the town in a boat. At the time of my visit the floods had disappeared. There was a number of pools with anopheles larvæ, but the city as regards mortality had more or less resumed its normal state.

Gujrat *thana* lies where several torrents from the hills debouch upon the Jhelum. The whole *thana* is intersected by the channels of these streams which are constantly bursting through their old beds and taking to new ones. Heavy rain at their sources greatly swells the streams and they then frequently flood large tracts of country. Many villages on old beds are also liable at such times to be flooded.

In this *thana* an analysis of village statistics gave the distribution of malarial mortality shown in the map. Visiting sample villages the results given were borne out by the conditions found. In village Nairowali, for example, which had an epidemic figure of 2, only eleven per cent of the children had enlarged spleens. The villages Gurali, Gurala, Jandiala and others all showed the usual condition found within the epidemic area, namely a spleen rate for all practical purposes of 100 per cent among the children and from 25—50 per cent among the adults. Nairowali was situated so that flood waters did not lodge but flowed away in three directions, they affected villages so that floods had collected and surrounded the villages with standing water.

It is interesting to note that anopheles were quite abundant at Nairowali so that the escape of this village is not due to any want of ordinary breeding facilities.

The tract of healthy villages shown near Nairowali bordered on the somewhat higher ground of Dingah *thana* which showed the effect of the epidemic to a much less extent than that on Gujrat.

Two patches of intense mortality at (1) and (2) were areas flooded by the overflowing of the Bhimber and the Shah Jehangir *nullahs*, respectively. The area near the Bhimber when visited was so flooded that the villages were approached with difficulty. The village Nand was on low land by the river and was flooded in 1908. Nurpur was in the deserted bed of the Shah Jehangir *nullah* and is inundated by this river when in heavy flood. The villages in the south-west corner could not be got at in the time at my disposal owing to floods which made the roads impassable.

The influence of physical features was made extremely plain in the Shahpur district. I investigated this district in order to ascertain the nature of the epidemic tongues I have previously referred to. The map gives on a larger scale the most northerly of the tongues indicated in the map of the 1908 epidemic. The fact that the epidemic tongue had been determined by the Jhelum riverain is very apparent. But it is very interesting to observe that passing down the riverain the epidemic conditions became less and less until at Sahiwal the epidemic figure was only 2.

An analysis of village mortality in this *thana*, which forms as you see from the maps a transition between highly affected and less affected areas, shows large tracts especially to the south towards Sahiwal in which the villages had very low epidemic figures. In other parts the villages exhibit high figures. One of these lies to the north bordering upon the affected Jaurian *thana*. Another isolated area lies at a considerable distance from the river to the east. The differences in physical features between the healthy tracts and the affected areas were obvious. Whilst the healthy ones were drier with subsoil water at a depth of 12 feet or more, the affected ones had been subjected to floods and showed subsoil water as in fulminant areas within a few feet from the surface. At village Wegowal, for example, the subsoil water was at a depth of only four feet and the whole area had been flooded by an inundation canal.

A very striking example of the effect of flooding was the village of Kandan which though it was situated amongst villages having low epidemic figures was conspicuous as possessing an epidemic figure of 30. This village was found to be situated unlike the others on low ground near the river and though not subject to heavy rain in 1908, it was flooded by the Jhelum itself.

It is worth mentioning also that of the *thanas* to the extreme west of the Punjab which had been severely affected, all are situated close to the large rivers and I suspect will be found to have been subjected to floods in 1908.

In the space at my disposal I cannot further increase examples but those I have given are sufficient to show the association between fulminant areas and flooding.

If we turn to other parts of the 1908 epidemic we can see the same effect of physical features produced in other riverain tracts. But as we pass away from the epidemic area, riverains cease to be affected. In 1908, for instance, we see several riverains exempt from severe epidemic conditions which in past epidemics have been picked out from time to time as fulminant areas.

One powerful determining factor of the intensity of epidemic conditions is then the presence of tracts exceptionally situated and characterised by being low lying and having a high level subsoil water. Yet it is clear such conditions alone without heavy rainfall do not lead to epidemic malaria. But with a given amount of rainfall they are more readily converted than more favourably situated tracts into fulminant areas.

But a glance at the epidemic maps shows us that such physical conditions are not absolutely necessary for the production of a fulminant area. Provided sufficient rain falls, almost any tract seems to be capable of being reduced to the necessary condition. A good example is Jullunder. Jullunder is comparatively rarely visited by large epidemics and appears to be able to stand a good deal of rain without becoming fulminant; but in 1894 when over 40 inches of rain fell it was nevertheless involved.

It would be possible then to map out the Punjab into areas of various degrees of danger as follows—

(1) Highly dangerous areas as, for example, the Jhelum riverain at Bhera, the Sutlej riverain near Ferozepore, Amritsar, Bangah Rahon and the *thanas* lying along the foot of the Siwaliks in Hoshiarpur, and so on.

(2) Areas affected by moderately heavy rain, such as much of Sialkot Gujranwala, Montgomery, Rohtak and Karnal.

(3) Areas requiring exceptional rainfall to affect them as the Bar in Shahpur, the central portions of the Lahore district, Lyallpur and others.

Some of these areas are perhaps scarcely ever likely to be profoundly affected as they lie out of the range of the monsoon rains. Others we cannot say when some special distribution of rain or of flooding rivers may not affect them, and others again we know to be frequently affected.

Before such a plan of differentiation could be carried out each *thana* would have to be visited and its salient features as regards its behaviour to malaria carefully appraised. We should then with the knowledge of the rainfall be able to predict not only general area and intensity, but to some extent the special distribution of the resulting epidemic conditions.

There are however some other matters which it is necessary to take into consideration.

Irrigation.

The very moderate effect of irrigation in these epidemics is very clearly shown. Areas irrigated by "inundation" canals are naturally physically suitable for epidemic conditions; but the great canals of the Punjab for the most part irrigate high lands unsuitable for epidemic malaria, and, in spite of irrigation and a certain amount of endemic malaria; stand out in relief as areas of low epidemic mortality.

We see here then Mian Mir in a truer bearing. However much the canals are infected with anopheles the true origin of severe epidemics would seem to be, as in the rest of the Punjab, flooding. Like the rest of the Punjab it is liable in some years to be affected; in other years it escapes. In 1904 and 1905, for example, the statistics show a small amount of sickness; but the same is shown everywhere; it is even apparent in the figures for the rural areas of the whole Punjab.

The effects of heavy rain are not the exception, but the one thing which mainly determines the year's eahlthiness or the reverse all over the Punjab.

The most serious effect produced by irrigation is an indirect one due to the general raising of the subsoil water and an increased liability to water-logging.

The influence of Squalor and Poverty.

If we examine in detail any town affected by the epidemic, we shall find that the heaviest mortality has been in those classes which are the poorest and living in the greatest squalor. This is very clearly shown in Amritsar, the death rates in 1908 among Mahomedans, who form the lowest classes, being in October 390 per mille as against 203 among Hindus, and in November 329 as against 181 among Hindus.

Again, Palwal as compared with the villages around shows a greater mortality rate. The malarial conditions in both are identical or slightly more adverse in the villages; but whilst Palwal has a large population of dependent classes living in great squalor and poverty, the villages have a population consisting for the most part of well-to-do cultivators with a small proportion only of dependants.

Bhera is a town at first sight prosperous and well-to-do, but a closer survey makes one suspect this appearance. There are in the town *mohullas* swarming with the lowest classes living in a very overcrowded and squalid condition.

Again if we ask why Amritsar shows such a peculiar liability to be visited by terrible fever epidemics, we can point not only to its physical conditions, but to its squalid populations, its industrial character, and so on. In fact in 1881 we

see a malarial outbreak the almost direct result of Kashmiri destitution at a time of industrial depression. Even in 1908 we find the chief epidemic centres just in those parts of the city largely populated by Kashmiris engaged in various fabric industries.

One may say that the amount of mortality in any town or village will be determined very largely by the relative proportion of well-to-do to partially poverty stricken dependant classes.

Scarcity.

The conditions we have just mentioned are local and probably do not greatly vary in any given locality. Another factor to be considered is the possible effect of general prosperity or the reverse from year to year. It is well known that for several years prices in the Punjab have been very high. The epidemic of 1908 is an instance of an epidemic associated with high prices. Looking back we see other examples of epidemics associated with or following periods of scarcity, as for example the great epidemic of 1879 which followed severe scarcity in the southern districts.

Comparing curves showing the price of food stuffs and the prevalence of epidemic conditions in different years, we see that out of the nine great epidemic years described, seven, namely those of 1878, 1879, 1890, 1892, 1897, 1900, and 1908 were during times of high prices. A great epidemic in 1869 and one in 1870 also occurred at a period of specially high prices.

The epidemics of 1884 and 1894 however were associated with low prices; 1876 was another epidemic year at a time when recorded prices were low.

What the conditions associated with the 1886 epidemic were, I have not yet been able to ascertain either as regards rainfall or scarcity; but in 1894 it is very noticeable that though the rainfall was very heavy and widespread the epidemic was one of the least intense and one of the most circumscribed of any we have described. In this year, Hissar, Rohtak, and Ferozepore received between 20 and 30 inches of monsoon rain, a quite phenomenal amount, but there was no epidemic in these areas the death rates not even showing any marked increase over the normal.

In 1884 not only was the precipitation in the affected area very heavy, Umballa receiving 44 inches and Jagadhari 71 inches of monsoon rain, but this year is recorded as one in which the very districts affected underwent great hardship owing to the failure of crops.

These facts certainly support the view that scarcity is a factor determining to a large degree the situation, extent and intensity of epidemics. But to ascertain the effect of this influence we require more information than the current prices of food stuffs; for whilst prices give us some idea of the degree of general scarcity, they fail to point out to us areas especially affected by failure of crops and other adverse conditions, the reason being that there is a very remarkable averaging process in regard to ruling prices so that however severely one area is affected by shortage of crops the prices after a brief discrepancy tend to level up if the other areas are unaffected. High prices may even increase the prosperity of a tract in which crops have been successful.

Without going further into this question which would require more space than I can devote to it in this paper, we may say that periods characterised by high prices are likely to be followed at the first heavy monsoon by an epidemic and that particular areas subject to adversity are likely to be picked out by epidemics if the other factors are favourable to this result. It is significant in this respect that whilst there are three types of epidemics, northern, central and southern, and that these rarely occur together in the same year, there are also three main types of agricultural areas, namely a wheat area in the north dependent mainly on the spring crop, a maize area in the central districts and a gram and millet area in the south, both dependent mainly on the autumn crop.

III.—Mechanism of Epidemics.

We are now in a position to discuss the actual mechanism by which epidemic conditions are brought about. We may briefly summarise our conclusions as regards the factors concerned in epidemics by saying that three factors at least are concerned—

(1) A general modifying influence of the effect of scarcity, high prices, and so on.

(2) Physical features of such a kind as determines water-logging and the collection of large sheets of water on the surface.

(3) Rainfall.

Curiously enough physical conditions associated with subsoil water at a high level, and with much standing water at all times of the year, do not bring about the epidemic disease unless rain falls in considerable amount; and though such places may exhibit a good deal of endemic malaria this does not apparently prevent epidemic malaria when it appears raising the death rate to many times the normal. Again though in an ordinary year sufficient rain falls to make many pools, and anopheles seem quite plentiful, the terrible fulminant manifestations of malaria are not exhibited.

What is it that enables a certain amount of extra rain so marvellously to alter the normal conditions, and in what way is it that water-logging acts in assisting epidemic conditions?

Before answering these questions we may with advantage ask; why is malarial infection in children at one time associated with but little mortality, and at another with such fatal effects?

That we are not dealing in these epidemics with any new form of parasite is clear from the results of blood examinations in Amritsar and elsewhere in which only the well recognised varieties were found. It is also perhaps scarcely necessary to say that the mere name malignant given to one parasite, and benign to another does not signify that one is fatal and the other innocuous.

What then is intense malaria?

Intense Malaria.

The answer to this question is I believe to be got at on the lines of some experiments I have undertaken in order to find out what was the effect on being bitten by a few or by a great number of infected mosquitoes. This point was raised by Colonel Leslie, I. M. S., and it seemed to me to be an important matter to determine. To carry out satisfactorily such an investigation on the human subject would be extremely difficult, but in proteosoma of birds we have a closely related disease very suitable for experiment. I ascertained in my earlier experiments that by using a large number of mosquitoes one could increase the severity of the infection and shorten the incubation period. Further experiment showed me that there were other factors than the number of bites. One of these is very important and must be briefly touched upon.

If a mosquito (*culex*) be fed on a sparrow whose blood contains only a few gametes of proteosoma, the mid-gut of the mosquito will on dissection naturally show only a few zygotes, and if a batch of mosquitoes so fed be examined when the zygotes have matured and the sporozoites have reached the salivary glands, we shall find only a very few of the salivary cells packed with sporozoites. It is evident that such a mosquito feeding on a bird will inject at the most a comparatively small number of sporozoites.

If we now feed some mosquitoes on a bird whose blood contains very numerous gametes, we shall find the mid-gut studded with hundreds of zygotes and dissecting such mosquitoes when the sporozoites have reached the glands, we shall find that these are packed and swollen to many times their normal size with innumerable multitudes of sporozoites. Such a mosquito must inject a dose perhaps a hundred times greater than one of the slightly infected mosquitoes we have referred to.

Using scantily infected mosquitoes even in large numbers it was difficult to get a severe infection; single heavily infected mosquitoes on the other hand often gave quite severe infections. But by using a number of heavily infected mosquitoes, not only was the incubation period reduced from nine days to as little as five days, but the resulting infections were much more severe and death in every case occurred.

When a bird already having parasites in its blood was bitten by heavily infected mosquitoes it still developed a new infection over and above the old.

The amount of infection carried by mosquitoes then depends on the number of zygotes which develop in the gut, and the number of these in turn depends upon the number of gametes in the blood of the sparrow by which the mosquito became infected.

It is easy therefore to see that in malaria everything may depend upon the existence of heavy gamete carriers; and if these are present, upon the number of anopheles. Otherwise the relation of number of anopheles to the amount of fever will not hold good.

Malarial infections must then be studied quantitatively. An endemic index of 100 per cent may be represented by a community containing only a few parasites in their blood and living in a condition of comparative health. In another case the same index may refer to a community heavily infected and prostrated by fever.

In the Punjab one frequently hears matters discussed as if the population was uninfected and remained so until the fever season came round when any individual was more or less liable to catch infection. It is nearer the truth to say that we have a population already infected and that what happens in the fever season is the "hastening up" of this infection and its kindling into a flame.

Bearing in mind these facts we may proceed to consider the effect of our three factors in bringing about an epidemic.

High Subsoil Water.

That a high subsoil water causes pools, that would otherwise be dry, to retain water is known to everyone; but there are some considerations in connection with subsoil water worth a brief mention.

When rain falls two forces are in action causing any collections of water unable to drain off to sink into the soil; these are gravity and capillarity. The relative value of these two forces depends upon the nature of the soil. In loose sandy soil gravity is an important force; in close impervious clay or silt this force acts much less effectively and capillarity is mainly concerned in the disappearance of surface water. This is clear from experiments which I hope to publish in another place, but which I have not space to give in this paper.

When by saturation of a fine silty soil like that of the Punjab, the power of exercising capillarity is wholly or in part done away with, rain water sinks in with extreme slowness.

It is thus that subsoil water acts in what are known as water-logged soils. If the subsoil water is at a depth of only a few feet the soil, even to the very surface, has drawn up moisture and has thus lost partially or wholly its power to absorb by capillarity: it is thus rendered extremely impervious.

When the subsoil water is on the contrary at a considerable depth, any rain falling on the soil finds it ready to exert its full absorbtive power, both gravity and capillarity acting.

When more rain falls surface water is still acted upon by capillarity because the soil at a given depth is still absorbing water from the upper portions. But if sufficient rain falls in a sufficiently short space of time, there comes about a condition in which either the descending moisture meets with the saturated layer above the subsoil water and capillarity ceases to act, or owing to the depth of moist surface soil, capillarity cannot act with sufficient speed to affect

the surface and again we come to water-logging, but in this case independently of subsoil water altogether.

Rainfall.

When water-logging has come about and rain falls the number of surface pools and the time they retain water is greatly increased. Still it is difficult to see why epidemic conditions cause a mortality so vastly in excess of the normal, for in every year a certain amount of rain falls and a moderate amount of rain should produce a proportionate effect. But the facts seem to show that rain must reach a certain amount before fulminant malaria can develop.

It is here I think our notions regarding malarious conditions require some expansion. We are apt as a result of the search for larvæ at all times of the year to look upon the various breeding places we find as the chief source of anopheles. In Amritsar, for instance, we may map out at any time quite a large number of breeding places, and if we do not trouble to think about the matter, we shall say perhaps that it is such a condition which gives us the disastrous results we have had in 1908. I venture to say that it cannot be so because otherwise Amritsar would always be affected, but we know that it is only now and again that malaria at all approaches the proportions it did last year.

The extraordinary and disproportionate exaltation of malaria when rainfall reaches a certain amount suggests the onset of some entirely new influence.

A New Factor.

This new influence can I believe be seen at work. If we visit a water-logged area during heavy rain we find not only a large number of pools, but we see the surface of the soil everywhere retaining little collections of water, the furrows in the fields hold water and swarm with anopheles, footprints of man and animals are breeding places, the very high roads retain shallow sheets of water perhaps less than half an inch in depth, which swarm with larvæ. If a house falls down pools may be formed in the debris and larvæ in hundreds may be found in such a situation. There is in fact something very different from a mere increase of breeding places such as we usually understand these to be. There has come about in fact, as a result of complete saturation of the soil, an abnormal state of affairs which enable anopheles to swarm just as when conditions being somehow very suitable, some insect pest occurs in such abnormal numbers as to destroy crops which normally they have little or no effect on.

The essential nature of the condition is I believe a biological one.

Anopheles keep their present moderate numbers only because innumerable young are destroyed before they reach the adult stage. It is usual to believe that this destruction is chiefly brought about by various carnivorous insects, fish, and so on. But in the Punjab such methods of reduction must be negligible: anopheles breed in freshly formed rain pools, and so long as these are being formed the species is subject to no effective repression. The one grand restraining influence under such circumstances seems to be the drying up of their breeding places. After every shower in Amritsar during this monsoon there were millions of larvæ destroyed by this means, and a succession of showers at such intervals that their effects disappear before the insects can develop into adults must be vastly prejudicial to the increase in number of the species. On the other hand if we do away with this deterring factor altogether as we do in a water-logged area receiving frequent heavy showers, scarcely any larvæ are destroyed; for even if the pools disappear the larvæ left on damp mud are able to survive and continue their development after the next shower has fallen. It is easy to understand then that the biological balance being upset there is swarming: and that the physical features of the Punjab are very suitable for this biological consummation.

If the view I am bringing forward be correct, the effect of floods is not so much that the sheets of water are themselves necessarily the direct source of anopheles but that by water-logging the tract they insure the biological state of affairs I have indicated being maintained so long as any rain is falling. On the

other hand of course the shallow sheets of water may act directly in the same way. Further investigation, especially of actual epidemic conditions, is evidently needed as well as an investigation of the whole subject of endemic malaria which by supplying the gamete carriers may be an underlying cause of epidemic conditions.

IV.—Prophylaxis of Epidemic Malaria.

I think it is evident from what I have said already that it is as epidemic malaria, and especially in the formation of fulminant areas, that the most disastrous effects of malaria in the Punjab are brought about.

At the risk of repetition I may reiterate the fact that in two months of epidemic malaria as many people may die as in a whole year of normal conditions and that it is epidemic malaria in a fulminant form which has prevented or minimised the normal increase of population in certain tracts of the Punjab. If we could prevent the mortality from epidemic fulminant malaria we should have removed the most urgent and distressing effects of this disease and those manifestations which the people themselves are most impressed by.

That with a proper organisation we should predict and estimate the proportions of an epidemic at an early stage is an important matter, for we should know in which year special ameliorative measures were most required and could as a result bring these measures to bear from the very beginning of the epidemic with special urgency in areas likely to be most severely affected. And that with a more detailed knowledge of the physical features of the country and of the economical conditions of the people as they relate to malaria, we could predict epidemics with certainty and accuracy is I think very probable.

The logical outcome of my conclusions as regards the origin of epidemics would seem to suggest as a remedial measure large drainage projects. Unfortunately epidemics are not confined to any given tract and may attack almost any part of the submontane or south-eastern Punjab. In 1890, for example, the most intense focus of epidemic malaria of which we have any record attacked Sialkot, an area we should have from previous experience at that time believed to be more or less immune. Under such circumstances drainage would mean that we should have to do what nature has failed to do, namely provide a drainage that will carry off excessive monsoon rain from the Punjab.

Still there remains the question whether certain specially dangerous areas might not be drained with advantage. There are also towns such as Bhera to be saved perhaps by drainage.

But it is necessary to remember that just as engineers when building a bridge or other work have to consider not the normal rainfall and to allow not for the normal rush of flood water, but for the abnormal, so if we seek by mosquito destruction to diminish epidemic malaria under the peculiar conditions of the Punjab, we must be able to control the breeding of anopheles not during the non-essential ten months of the year, but during the two months or so in which the whole mischief is done, the two months when flood rains fall and water is everywhere, when anopheles are breeding in the furrows of ploughed fields and in innumerable situations where owing to the impervious and sodden soil the tiniest collections of water can rest.

So also if we carry out large hydraulic measures, we have to calculate on the conditions which produce epidemics, not on those in a normal year when there is no question of flooding.

A case in point is the town of Bhera, which it is proposed to drain by a dyke into the Jhelum. Such a drain in the very year of need will be found wanting, for under such circumstances the Jhelum itself is likely to be in flood, and in one year actually was the cause of the flooding of Bhera and a resulting epidemic.

But even if we decide upon drainage measures as suitable for attacking malaria in the Punjab, it will be very many years before any serious change for the better is effected by this means. In the meantime there is only one thing

we can do to save lives in the case of an impending epidemic. The villages themselves cannot, as has been sometimes averred, cope by means of anti-malarial operations with such conditions as I have attempted in this paper to portray. For urgent treatment of an impending epidemic we have only one efficient weapon to hand, namely quinine.

But quinine may be used in the prophylaxis of malaria in many different ways, and if we intend to get the best results we must know exactly in which of these ways we intend to use it. The Italians have tried the effect of quinine prophylaxis in the inter-epidemic period, and after a trial of many years have come to the conclusion that it is useless to try to prevent an epidemic in this way. Their remarkable results in mitigating the mortality from malaria are due to quinine prophylaxis during the time of the epidemic.

We should take a lesson from their experience. Strictly speaking, to meet the conditions we are referring to, it is not quinine prophylaxis but quinine treatment we are in need of. The ideal of a successful organisation to meet the epidemic malaria of the Punjab would be that every family was taught to know the value of quinine to cure fever, that they were able to get quinine, and by this means to save themselves not only from death but from the effects of untreated malaria. We must not confuse methods suitable for small communities with those suitable for large populations, or forget that in attempting to reduce mortality in India we are proposing to undertake a task infinitely greater than anything of a like sort previously attempted in any part of the world.

The following discussion ensued :—

Colonel King said that Captain Christophers had treated the matter in an exceedingly scientific manner, but it was necessary to remove oneself from the glamour of his methods and to test his results from a practical point of view. Captain Christophers' paper led one to think that the question of drainage was going to have a happy ending, but in the manner of some novelists he had killed off his hero. So long as there was a continuous sheet of water on the soil he thought mosquito propagation was not much encouraged and he thought Captain Christophers would agree. Consequently the harm occurred, not when the extraordinary water was on the soil, but when it receded and left pools of water. Captain Christophers complained that in the Punjab nature refused to deal with rainfall above a normal average, but this was merely a question as to the rate at which it went, as a large or small body of water would go by the same route. One was sent back therefore to the condition which Ross recognised of pools in the neighbourhood of dwellings. He next referred to the point which had been touched upon that although in certain years there had been an increase in the rainfall there had been no increase in malaria, and *vice versa*, and here the investigation stopped with a suggestion of mystery. But as a matter of fact there was in operation in the Punjab no mysterious influence directing the occurrence of epidemics. These apparently depended upon well recognised laws. Some of the maps on the wall showed that rainfall was irregularly distributed. This being so, if the Punjab was an area that was subject to change in the course of the rivers, as he understood was the case, substreams would be formed in definite directions and it followed that the point to which the subsoil water might rise in one year might not be due to rainfall in that area but to distant rainfall, and these facts sufficiently accounted for the variations in endemic and epidemic malaria in localities perhaps distant from each other. In short the paper showed that Captain Christophers had reached a point when an investigation by medical and sanitary experts should have been allied with that of an expert drainage engineer. The " epidemic tongues " to which Captain Christophers had referred were really the old beds of rivers and in certain times of the year and in certain years the water level of these appeared on the surface. The tongues were originally formed by diversions of the river and diversions probably are formed by clay beds. Consequently in many cases it should be possible for an expert drainage engineer to overcome such obstructions by piercing them so as to reach suitable points of outflow, or in cases where such expenditure would be feasible even by pumping above the point of obstruction. Thus water supplied from subsoil sources might often prove of benefit indirectly by depressing the

subsoil water level in such areas. [The speaker was proceeding to illustrate his argument by referring to the situation in Cuddapah when the President drew his attention to the fact that he had exceeded the time-limit].

Mr. Ferard asked with reference to the point regarding the mortality of children, if Captain Christophers could give information on the following point which was raised by Major Robertson, the officer on special duty in the United Provinces. " Why is it that a native child infected with two or three different types of parasite will, on getting an attack of fever, very often show in the peripheral blood only one type of parasite and at the next attack may show another type? I used to think that the majority of infections were simple, but more and more I am coming to consider the rule is just the opposite, that infection with more than one type of a parasite is the rule and not the exception, even though clinically and by cursory blood examination the infection may appear simple."

Captain Christophers agreed that a large number of children have double infection or even triple infection.

Major Donovan asked what species of anopheles had been noticed by Captain Christophers. It was very interesting as regards these epidemics of malaria that they did not occur everywhere. In the Madras Presidency they had no such epidemics. Then again why did they occur in the dry regions, for instance, in the North-West Frontier Province and in parts of the United Provinces? Is epidemic malaria found in Rajputana and Sind? The problem of the swarms of mosquitoes was analogous to that of the swarms of locusts which occurred in dry regions and the conditions requisite for swarming might be similar.

Mr. Ferard said that in 1908 the epidemic in the United Provinces was carried down as far as Muttra.

Major Wilkinson said that in the chapter on INTENSE MALARIA, Captain Christophers had used the following words. " Using scantly infected mosquitoes, even in large numbers, it was difficult to get a severe infection; single heavily infected mosquitoes on the other hand often gave quite severe infections." It seemed to him that when there was a large number of infected mosquitoes, then there were present all the conditions required for an intense outbreak of malaria, and it was not necessary to have an intensely infected mosquito. Was it possible to prevent an extraordinary development of the mosquito? If circumstances pointed to a large epidemic of malaria was it possible to deal with the mosquito in any form? How do the epidemics start on the supposition that an intensely infected mosquito was required to begin with? At the beginning the children from whom the infection was derived were not particularly infected with malaria. He was very much disappointed that Captain Christophers did not suggest some measures. He drew attention to the fact that these epidemics were of very sudden occurrence and rose suddenly at a high rate. For this reason he thought one should be prepared with measures of some kind.

Captain Christophers said that the fact that epidemics appeared so suddenly suggested that many heavy gamete carriers existed previously. These were largely found among poor and squalid communities in Indian towns and villages. Colonel King's remarks that the harm occurred not when the extraordinary water was on the soil but when it had receded and left pools, were not in accordance with the facts.

Major James considered it very desirable for the Conference to come to a decision regarding the necessity of investigating the epidemiology and endemiology of malaria in every province. Captain Christophers had begun his paper by saying that malaria in the Punjab presented certain special and peculiar features and the trend of the discussion seemed to show that this point should be emphasised. From the results of the Punjab investigations we are not entitled to generalise and to say that similar factors are at work in producing severe malaria in other provinces. Indeed we know, for example, that while in the Punjab intense epidemics are the result of floods, such floods commonly occur in Assam and other parts of India without causing malarial epidemics. So far as investigation has at present gone it teaches that in each malarious tract of India there is a prominent epidemiological factor, but that this factor, is different in different tracts, so that until we learn for each tract the factor of most importance we

shall in our endeavour to combat malaria constantly commit errors which may be of great magnitude. It is evident therefore that if we are to succeed in our endeavour to mitigate malaria we must first know thoroughly the story of the disease in each province, and every new detail added to this story will be a new weapon by which the disease can be fought. It is very desirable therefore that arrangements should be made for epidemiological investigations in every province and it would be of great advantage if the results of these researches could be collected together and published in a connected manner every year as is done in Italy.

The President asked Major James to prepare the draft of a resolution embodying his suggestion.

Colonel Lukis referring to Major Wilkinson's remarks to the effect that Captain Christophers had made no suggestion for measures in rural areas, read a passage from the " Pioneer " which contained a copy of a letter from Major Ross. He asked Captain Christophers whether he had dealt with rural areas.

Captain Christophers replied that his paper was concerned almost entirely with the conditions of epidemic malaria in rural areas.

He also said that Colonel King had objected to certain points in his paper in connection with rivers carrying off flood water ; all he meant was that any scheme to carry off flood water in the Punjab must be something of an extremely gigantic nature. Colonel King's other point made one realise how great was the difference between endemic and epidemic malaria. The difference might be because in the one case, although anopheles were present, they were not present in swarms. In the Punjab they swarmed more largely than in other parts of India. This condition of affairs was not connected with a limited number of pools. In reply to Major Donovan's question as regards the species of parasites discovered, he said that they were chiefly Benign Tertian and Malignant Tertian. The species of anopheles mostly in evidence were *A. rossi*, and *A. culicifacies.*

The President explained why it had been necessary to discuss Captain Christophers' paper before discussing measures. It seemed to him that adequate knowledge of the chief conditions associated with the appearance of epidemic malaria and a knowledge of why, for example, heavy rainfall in one part of India produced intense malaria while in another part it had no such effect, were essential preliminaries to the discussion of measures. He did not think that the great difference between the prevalence of malaria in Burma and in the Punjab could be accounted for by differences in rainfall and drainage, and he attached great importance to what Major James had said that it was most desirable that this Conference should recommend endeavours to investigate more fully this subject of the epidemiology and endemiology of malaria. All measures of drainage were very expensive ; it was also known that quinine prophylaxis, if not expensive, is very difficult, more difficult indeed than drainage. In the course of investigations other measures might be discovered which were not open to financial and other objections.

The discussion upon MEASURES was then begun.

Mr. L. M. Jacob, said " Sir Harold Stuart has asked me to say a few words on a matter which he thought might interest the Conference.

I have been a Punjab Irrigation Officer for many years and my acquaintance with the Punjab has been wherever there are irrigation canals, and not merely where there are canals in actual operation, but where canals have been destined to be made. My general experience has been that wherever there has been over-irrigation, leading to water-logged soil, malarial fevers have been very pronounced, and the health of the people in those parts has been in marked contrast to that in the desert and more arid tracts of the province.

I would instance the case of the Western Jumna Canal in the south-east Punjab. This is a very old canal, dating from the 15th century, which from the time when it was taken over by the British Government has been gradually improved into its present state. The old canal crossed every drainage in the

course of its alignment, sometimes it even ran in the drainage, its supply was in excess of the needs of its commanded area, the country that it irrigated was too freely supplied with water, and these circumstances led to lamentable results, the fertility of the soil being greatly impoverished and the health of the people most injuriously affected. The mass of the inhabitants of the tract had enlarged spleens, which, I understand, was the result of malaria, and it was said that the men were becoming impotent and the women sterile.

The new canal nominally released the drainage lines, but really did nothing until the question of opening out the many blocked drainages was seriously taken up. The subject was one of some difficulty as the drainages ran largely through valuable rice and sugarcane lands, and any scheme of deep drains would have been both very expensive and very unpopular on account of the land it would have been necessary to acquire. The system I proposed, and which was approved by Government, was to clear all the arterial lines of drainage to a suitable out-fall by means of very shallow, saucer-drains, without the acquisition of any land other than that required for the one large out-fall channel. It was necessary to arrange that the village tanks should maintain a sufficient supply of water for watering the cattle and for domestic purposes and in carrying this out the villagers concerned were asked at what level they wished the water in the tanks to lie at the close of the monsoon season. Between the tanks the drainages were cleared of all natural and artificial obstructions, such as watercourses, and graded to suitable slopes. I explain this by the diagrams I proceed to draw. The cross-sections were arranged as in this sketch, the soil was spread in a thin layer over the adjoining ground, and on the completion of the works the land remained the property of the original owners who were free to cultivate it. In this way, much swamped, but otherwise valuable land, was reclaimed, and heavy rainfall was enabled to pass on, along the natural depressions of the country free of obstruction, to an outfall, and at very small expense. The people were so satisfied with the system that in many cases they paid for the clearance on the same system of minor lines of drainage.

I should like however to explain that the complete amelioration of this tract was only arrived at when, in addition to the clearance of the drainages, we also extended the scope of the canal and brought a large additional area under command. The extensions led to a far greater economy in the use of water. Irrigation in itself, properly managed, need not lead to any water-logging, it is only when water is used greatly in excess of crop requirements that in addition to supplying the necessary moisture to the crops it enters the sub-soil and raises the spring level to an undesirable degree. I believe I am correct in saying that the conditions of both the health of the people and of the soil have vastly improved since the above operations were carried out.

Major Wilkinson : I am acquainted with the Punjab and can say that the canal district has certainly improved.

Colonel Bate : Yes, it has improved.

Mr. Jacob continued. In the Amritsar district, where the Bari-Doab Canal has also over-irrigated the land, a scheme is under investigation for supplying water in irrigated areas by means of pumping from the sub-soil. The advantages of such a process are very great, the land and the people are suffering for the same reasons that the old Western Jumna tract suffered. The soil is becoming water-logged and the spring-level has risen to within a few feet of the surface. Over-irrigation by flow from the canal can only intensify the soils; but if the necessary supply of water can be obtained from the water-table below the surface, crops can be grown as before without the natural consequences of a swamped or sodden country, and the water saved from the canal can be led to where it is most essentially required. I believe that more restricted irrigation and the opening out of the natural lines of drainage will improve the conditions of all malaria-stricken, over-irrigated canal tracts in the Punjab, in the same way that the action taken in the old Western Jumna country proved beneficial.

Colonel King then read the following section of a report which he had prepared for the information of the Conference :—

The difficulties which beset the practical application of Anti-Malarial measures

BY

COLONEL W. G. KING, C.I.E, I.M.S.

One of the first questions that naturally would occur to the mind of the enquirer is as to whether sufficient attention has been paid by the various Governments of India and their sanitary officers to the importance of anti-malarial measures, especially subsequent to Major Ross's important discovery. My experience extends only to Madras and Burma. As already stated, in Madras, in 1900, special exhortations to all local Bodies were issued as to "mosquito brigade" methods. By 1904, preparations were made for an extended campaign on principles advanced by me and definitely approved by the Government of Madras (G. O. No. 917, Local and Municipal, dated 2nd August 1904,) in which mosquito brigade work and the issue of quinine occupied an important, but minor position, and the special necessity for radical cure by minor sanitary engineering works was particularly impressed upon local Bodies. For this purpose, not only were Sanitary Inspectors already qualified in sanitary engineering to be employed, but over these were to be Assistant Surgeons trained in minor sanitary engineering, under whose orders Public Works Department subordinates were to be appointed. Why this excellent scheme has not proved more successful in practice, is a matter that furnishes experience which I hope may be useful to this Conference. In Burma, in 1902, Colonel Little issued special instructions to local Bodies encouraging the formation of mosquito brigades. In the same year, that officer instituted amongst the Military Police the prophylactic use of quinine and the employment of mosquito nets in the hospitals of that force, as well as in the civil hospitals of the province. Attention to this matter was likewise given by Colonel Macrae, his successor. Within a few weeks of my arrival in Burma, I received special orders from Sir Herbert White, the Lieutenant-Governor, to investigate certain highly malarious localities and report on suitable anti-malarial measures. The Government of this province has also given every possible encouragement to the sale of quinine, the better sanitation of malaria-bearers represented by the Military Police, and the formation of mosquito brigades in towns. This province also possesses a Commissioner (Mr. Houghton, I.C.S.) through several years in charge of the large Tenasserim and Arakan Divisions, who has toiled incessantly to promote anti-malarial measures, in which he has strong belief. I have been succeeded in Burma as Sanitary Commissioner by Major Williams, I.M.S., whose enthusiasm in all sanitary matters is widely known. Civil Surgeons who are also Health Officers of their districts have not failed in their attention to the subject. With this obvious willingness of both Governments under which I have had the honour to serve, and distinctly every wish on the part of their sanitary officers to aid anti-malarial measures, it may well be asked why I cannot to-day point to any locality in which it may be said malarial fever has been absolutely extirpated.

What are the difficulties in practice which have prevented the accomplishment of hoped-for results? It stands to reason that the enormous strain upon the resources of local Bodies who, in late years, have been afflicted with plague, has not only done much to divert the total energy and staff at disposal, but the finances—without the existence of which no advance is possible. Together with the weary struggle against plague, the introduction of water-supplies, drainage works, conservancy and house improvement schemes have necessarily demanded much attention in a country, which, in many parts, admittedly has been obliged to commence sanitary efforts, within the last few years, *ab novo*. So that if startling testimony as to the efficacy of anti-malarial measures is not forthcoming, we are at least able to meet at this Conference with experience gathered in various parts of India of the difficulties that must be encountered even in normal times ; and hence, should be able to make suggestions to meet them. In this sense, I would proceed to deal with the applicability of various recognized anti-malarial measures.

Mosquito brigade methods.—Efforts under this head form but another of the numerous pleas that can be advanced for the existence of an organized sanitary staff that shall not consist solely of advisory medical officers of health, but shall possess correctly educated and skilled executive staffs sufficiently strong to be absolutely in touch with the people, and the necessities of daily and routine sanitary care. The Madras Government, as far back as 1894,* rose to the occasion and now possesses a large and correctly educated executive sanitary staff that but awaits the better development of its higher branches to render it an absolutely effective organization. In 1895 the Government of India† propounded a sanitary organization scheme, which apparently most Local Governments did not adopt. By 1907, the Government of Burma also proposed a definite sanitary organization of which the main feature was the education of men as provincial Sanitary Inspectors, under the control of correctly qualified Health Officers. Subsequently, and, in the same year, the Government of India circulated proposals to all Local Governments in the hope of evolving a sanitary organization scheme. We approach 1910, but no sanitary organization yet exists in Burma ; and I think this is the case in most parts of India—at least in respect to the all-important factor of a specially educated executive in proportion to the population treated. To such staffs then, and not to spasmodically enlisted " mosquito brigades," should palliative methods be relegated *as a part of routine sanitation*. Anti-malarial efforts of this minor class, I conceive, should be recognized and practised as adjuvants even in the presence of accomplished radical anti-malarial measures for many years.

Quinine prophylaxis.—So long as radical measures have not been adopted, quinine prophylaxis must be regarded as of special importance in dealing with jails, and disciplined bodies of Military Police and troops. That the people may ultimately use quinine largely for prophylactic purposes is a pious hope that has possibilities in it ; but it stands to reason that so long as a population is free, this measure cannot be looked to for the extermination of malaria. An essential point for encouraging the sale of quinine is that the Governments concerned when placing quinine at the disposal of local Bodies, should give it at the actual market rate and not at probably what is the cost of production. Such loss as must occur should be contemplated with equanimity.

To control the malaria-bearing policeman who must be a very real factor in the spread of malaria in a country where *quasi*-military precautions are necessary in respect to transport of treasure, it is apparently sufficient in Burma that the interest evinced by the Government and by the Inspector-General in administrative charge of the large military police force there, should continue; so that the present anti-malarial measures of improvement of out-posts, of localities on the routes of escorts, prophylaxis by giving quinine, the use of nets, etc., may be systematically pursued.

But careful legislation would be necessary to throw upon the employer anti-malarial measures for the protection from infection of collections of coolies. Examples of such legislation exist in Italian Law.

Dry zones and removal of dwellings.—The removal of dwellings may obviously be a radical anti-malarial measure if the distance of removal from an infected centre be sufficiently far, and, especially, if it be accompanied by the adjuvant measure of quinine prophylaxis in respect to persons so moved. Equally so, enforcement of dry zones may be a radical measure, if within that zone palliative measures be also adopted. Failing these, if used alone, the dry zone must at least be classed as a valuable palliative ; unless the configuration of the country be inimical, and the control of surplus moisture be impossible without engineering measures, in which case its application would be useless.

In these measures, the difficulty is encountered of vested interests in property being involved, and their practicability must be considered on the usual sanitary lines that the resulting good to the majority must be indubitable, when alone the

* It has been frequently asserted that action by the Madras Government was due to the valuable suggestions made at the Indian Medical Congress of that year. This is not the case. A definite scheme for training and employment of Certificated Sanitary Inspectors was sanctioned prior to that Congress.

† Government of India, Home Department, No. 11—313-326, dated the 26th October 1895.

minority may be called upon to suffer. As to the class of places where dry zones would be of utility, there must be no confusion between zones made on the ground of general health and those required for anti-malarial purposes. The fact that the fever present in a locality is really malarial and affects the prosperity of the people, should be definitely proved as a first step before advising the use of a dry zone.

It is not necessary within dry zones to prohibit any form of cultivation in which the moisture required is not in excess of the absorptive power of the soil. To place water at disposal for cultivation of this class within a dry zone, it is necessary to either arrange for a definite velocity of streams with trimmed edges, or employ well-jointed pipes or impervious conduits for delivery. Wells within the zone should be provided with covers and, preferably, pumps be employed.

Borrow-pits.—In the Madras Presidency, by a Government ruling, the Public Works Department is prohibited from allowing borrow-pits to be made within certain distances of villages, and their drainage is enjoined. It is, however, necessary to restrain, by legislation, railways and general contractors from making borrow-pits without providing for their correct drainage. Railways are apparently compelled (chiefly in their own interests) to provide for waterways in running their embankments across drainage gradients; but such rulings should be enlarged, so as to secure that not only the safety of railway lines but of the neighbouring people from possible malarial outbreaks is assured.

Radical measures.—In these measures, as already defined by me, I would include all engineering efforts for sub-soil drainage, embankments, silting and other methods of bringing about correct control of surplus moisture on soil. The actual works necessary of this nature in a locality, as a fact, may be extraordinarily few; although, in their absence, complete anti-malarial results cannot be hoped for. It must at once be recognized that special funds would be necessary besides a special staff for their execution. *Hence, whilst those measures classed as palliative should be looked for from the ordinary sanitary staffs of local Bodies, I think, not only special legislation giving powers to Local Governments is necessary but that special anti-malarial funds must be found.* It is beyond my function to suggest whence funds can be obtained; but unless this Conference is to be a mere stop-gap in the sanitary history of India, they should be definitely forthcoming. Such funds should be so provided that they cannot be diverted to other possibly urgent sanitary requirements. Steadily and uniformly, year by year, radical anti-malarial schemes should be worked out in full detail, be funded, and be executed.

What should be the nature of the staff advising Governments as to radical anti-malarial measures? I am sure that to most officials, the answer to such a question would present no difficulty whatsoever. It would be stated that it would be for the Sanitary Commissioner, in consultation with local authorities, to advise a scheme in sufficient detail for his intention to be correctly interpreted, and if funds were duly provided, the Public Works Department would, in due course, see to its execution. To me, however, the matter presents no such simple solution; and if I indulge in some plain talking on this point, I hope it may be understood that I do so with the conviction that unless some better method were devised than this, in 99 cases out of a 100, schemes would never go beyond the files of offices. The first difficulty to be overcome is the very obvious one that all sanitarians are not engineers, and all engineers are not sanitarians. In conducting anti-malarial measures, therefore, one Department must be in control of the other. I may be biased: but it seems to me that there should be no doubt whatsoever that, up to the stage of execution, the engineer about to attempt sanitary works should be under the control of the sanitarian. Hence, I would not relegate anti-malarial measures *in the stage of evolution* to the ordinary officers of the Public Works Department. In their hands, or in those of private contractors, works might be executed; but, for the evolution of a scheme, there can be no question that the ordinary official engineer is not suitable. I say this, I am sure, without risk of giving offence to the learned and highly skilled body of engineers to which India owes so much. On the opposite, my meaning only emphasizes the truth that engineering is no petty science, but embraces specialities which are day

by day increasing. In this, the analogy is found in the case of the medical profession. Were a medical man to require a second opinion on a subject of any importance, he does not think of going to the general practitioner but he consults a specialist—that is, a specialist in the now alarmingly numerous branches of medical and surgical work. Of course, the general practitioner can become a specialist just as the engineer may, with time and opportunity, become a specialist in electricity, in sewerage, in water-works, mining, ship-building, etc. I do not suggest that the development of the specialist engineer means the ripening of experience at the cost of public funds, but if my analogy is correct, it is worth remembering that the eye specialist is popularly credited with gaining his skill at the cost of a "hatful of eyes." In short, the general practitioner engineer cannot be taken at a moment's notice and converted into either a mining engineer, or a successful irrigation or drainage engineer. Hence, for dealing with anti-malarial measures, there must be special appointments under Local Governments of drainage engineers properly so called, to the exclusion even of his ally the sanitary engineer, whose work overlaps the subject of drainage; that is, *men are required who have learnt their duty practically on large drainage works in other countries*—not men who having been general practitioners in a province, because they suddenly show an interest in one or other of the subjects involved, are ordered to fulfil special functions. Such selected men should be subordinates to the Sanitary Commissioners of provinces, and be absolutely at his disposal; but it should be required that a method of free inter-communication should exist between the Sanitary Commissioner and the Director of Agriculture as to the agricultural aspect of anti-malarial questions, and the local civil authorities in respect of the financial aspect of revenue. Under the care of the Sanitary Commissioner, thus aided, plans and estimates for anti-malarial works should be estimated for down to the last detail. But such a solitary specialist whom it is presupposed would be provided with a suitable office and field staff, would not suffice for overtaking many of the minor demands in provinces. Hence, the necessity for an imitation of the same scheme in each district. Each district should have its Health Officer on the staff of the Sanitary Commissioner in close communication with the Civil Surgeon, although, only in certain details, subordinate to him. Under this officer, there should be not only a staff, in proportion to the total population of the district, of certificated Sanitary Inspectors trained in minor sanitary engineering, but, under his special orders, there should be not less than one capable Public Works Department upper-subordinate and draftsman. Thus provided, a Health Officer could evolve numerous minor radical schemes, and, in communication with the local authorities of districts, and at the cost of the local funds, make year by year steady progress. Under such a simple organization therefore, it will be seen that all palliative anti-malarial measures as well as radical measures requiring but minor engineering efforts would come under the control of local authorities, whilst for the execution of larger works demanding provincial funds, their consideration would pass into the hands of the Sanitary Commissioner, provided with a special engineering expert, and their execution would depend upon the resources accumulated in the anti-malarial fund.

In describing progress of anti-malarial measures, I alluded to the fact that the Madras Government had, in an Order dated the 2nd August 1904, No. 917L., practically approached this method of dealing with anti-malarial measures. Why it failed at this crucial point is beyond my knowledge, although I viewed the matter with regret at the time. I can only suppose that too much was expected from the funds of local bodies, whilst the Government itself as the only alternative, had no provincial funds to offer for recurring charges for staffs. The result however was that Assistant Surgeons after a course of sanitary engineering have been appointed as Health Officers of districts at the option of local authorities, and are expected to be paid by local bodies; and this being so, their legal control passes to the paying authority. To this the difficulty is added that local bodies fail to see that unless Public Works Department subordinates are placed at the disposal of the officers, their sanitary labours could rarely rise above the results expected of Sanitary Inspectors. For the organization, I have portrayed, therefore, to be effective, there must be nothing left to volition on the part of local authorities. A sanitary organization, such as is held by the Government of the province concerned to be suitable for each district, must be put defi-

nitely into existence, and preferably should be a provincial body subject to the authority of the Sanitary Commissioner; and whether the Sanitary Inspectors' grade belongs to the provincial service or not, it seems to me quite clear that the superior grades of Health Officers should be so. With an organization of this description, not only could anti-malarial measures be undertaken vigorously, but there would result a general advance in the sanitation of the country.

General lines of legislation for removal of existing difficulties.—In the enforcement of zones, the interests of private individuals alone are not affected—the resources of Government largely depend upon the revenue product of irrigated lands and not until the mineral and industrial resources of India have been greatly developed can such loss be regarded with equanimity; even if, as I contend, it is possible to localize the great centres of malaria, and thus minimize resulting financial questions. Hence, in dealing with dry zones, one has to contemplate the loss of revenue in perpetuity to Government, and the necessity of meeting the losses of private individuals by monetary compensation. This should, when possible, always be the difference of the profit accruing between wet and dry crops. Unfortunately, in Burma, it will take a long time for the cultivator to receive such a system. If he be not allowed wet cultivation, he will not cultivate at all. Hence, outright purchase must usually be contemplated.

To meet these requirements, expansion of existing legislation is necessary, and recommendations on this subject by the Conference would seem to be essential. A recommendation as to minimum size of zones would have to be approached—based on the still uncertain existing knowledge of the length of flight of the mosquito, and practical experience of their efficacy. So far as I can see, although sanitarily it would sound illogical, it would be but reasonable, in view of financial necessities, to desire that zones should recognize grades of protection having regard to the size of the population concerned. For full protection, I think the size of a zone should not be less than one mile.

Practical experience shows that legislation for important anti-malarial measures must not be merged in existing Acts administered by local bodies. It is a hopeless matter, for example, to say that a zone shall be confined to the whole of a municipal area. This sounds well; but, in practice, it may exclude lands under a rural local body within the striking distance of the mosquito. Further, such legislation must be accompanied by rulings that, whilst not crippling other forms of cultivation classed under dry and garden, shall hold them in such control that the tenant shall not place upon the soil more water than it can absorb, or permit it to run to waste without definite and final disposal.

I would specially commend to your notice the necessity for legal measures that shall ensure that, in localities recognized as malarious, no new wet cultivation shall be conducted without the owner furnishing a record in which shall be exhibited not only the means for bringing water on to the land but taking the surplus off. It is not, in my opinion, the mass of water which passes over the land for irrigation that one need fear so much for mosquito propagation, as the absolute apathy with which both the cultivator and all authorities concerned view the careless formation of pools and puddles, after the water has fulfilled its function. Plans for major irrigation works also should not only take note of how the water is to reach land to be cultivated, but also how it is to be removed therefrom.

Further, whether or not it would imply gain to Government to ordinarily use such methods in the supervision of irrigation as shall lead to cultivators using no more water than really is required under irrigation systems, it should at least legislate that in malarious areas special measures of control should be adopted by officers responsible for water distribution.

Rulings are also requisite for the removal of dwellings likely to impair the perfection of zones, as, necessarily, these should have their measurement from the most external dwelling of an inhabited area. The removal of houses liable to be inhabited by persistently infected individuals from the neighbourhood of bodies of disciplined men and Government institutions, would also seem reasonable. In urban areas, provision for throwing upon the tenant, or owner, the onus of maintaining the premises of dwellings in a condition that shall facilitate palliative

measures, or, failing such precautions, would enable the local authority to act summarily, would demand expansion of existing rulings. The sanitary care and prophylaxis of large coolie gangs recruited from malarial regions and imported into distant localities also demand special legislation. Such measures should also indicate the cheap provision of quinine in highly malarious areas for the general public, and aid by the medical and sanitary staff of public bodies at the cost of the employer of large coolie gangs. The making of "borrow-pits" must be subject to rulings appropriate in respect to locality.

Summary of measures advised.—To summarise therefore, I would advise that to meet the present demand for greater activity in anti-malarial measures in India, the following are the requirements:—

(1) That "mosquito brigade" and other palliative measures, together with supervision of systems for cheap provision of quinine for the general public, should be regarded as coming within the scope of routine duty of a correctly organized Executive Sanitary Department, the existence of which is essential in the health interests of the country;

(2) That these measures should be combined with quinine prophylaxis and mechanical protection from mosquito bites wherever feasible with due regard to toleration of individual and personal liberty, wherever disciplined bodies of men are dealt with;

(3) That coolie labour is an important factor in dissemination of the causative agent of malarial fevers, and that special rulings to secure the use of anti-malarial measures, consistent with reasonable liability of employers, the liberty of the subject, and the importance of the body of coolies in respect to numbers, are necessary for its control;

(4) That although diffusion of malaria occurs from time to time under specific conditions, especially by transfer of labour, it is eminently a disease of localities, and that consequently *radical* anti-malarial measures should be directed against the great centres of malaria prevalence, in the interests of the rest of the country;

(5) That in the treatment of these great centres whilst no palliative or prophylactic measure should be neglected, radical results can only be looked for by engineering measures directed to the control of surplus moisture on soils;

(6) That whilst all palliative, prophylactic, and minor radical measures may safely be delegated to a correctly organized Executive Sanitary Department under local authorities, efforts directed against the great centres of malaria prevalance should be organized as follows:—

From sources to be ascertained by local Governments, each province should form a cumulative "Anti-Malaria Fund," which should be devoted solely to expenditure incurred on the extermination of malaria, by radical measures involving the control of surplus moisture.

The local Governments concerned in respect to these measures should be advised by the Sanitary Commissioner of the province, who should be aided by an expert Drainage Engineer, provided with suitable field and office staffs for the preparation of detailed plans and estimates.

The detailed plans and estimates so prepared should pass to the Government concerned through the Sanitary Board of the province: but, in the event of the Sanitary Board or the Secretariat officers of the Public Works Department or other officer consulted by Government, advising the rejection of certain portions of schemes of an expert sanitary or expert drainage engineering nature, such difference of opinion may be referred by the Sanitary Commissioner of the province to the Sanitary Commissioner with the Government of India, who should place the matter before the Sanitary Commissioners and Drainage Engineers of at least two provinces, and the Government concerned shall then be definitely guided in its decision by the opinions thus gained on the particular expert point raised.

(7) That a Special Anti-Malarial Measures Act for India is necessary, which should be capable in part or whole of being applied by local Governments to highly malarious areas, and of being in part incorporated with, or withdrawn from, existing Acts administered by local bodies.

The following paper was then read :—

Malaria in Cantonments. "Wanted a Policy"

BY

LIEUTENANT-COLONEL H. B. THORNHILL, C.I.E., I.A.

In common doubtless with many other officers whose duties are connected with the sanitary condition of Indian Cantonments and the health of soldiers and others therein, I have been struck by what appears to be the unsatisfactory line of action that is at present adopted with regard to the prevention of malaria. While this is obviously due in great measure to our lack of definite knowledge regarding the best methods to employ, the present line of action exhibits, I venture to think, some fundamental errors to which it is advisable attention should be drawn.

It seems to me that the most striking of these is the fact that the tendering of advice upon the subject of malaria prevention in Cantonments, is not confined to a few officers, who from study and experience are qualified to be regarded as experts, but is the common practice of almost everyone who is connected, either closely or remotely, with the Army in India. The result of this flood of advice by irresponsible persons is the receipt by the authorities who have to find the money for the schemes, of numerous recommendations that are unpractical, impracticable, and futile. An instance that is neither worse nor better than many others, is afforded by a perusal of the Sanitary Officers' reports for 1908, where in regard to Peshawar, it is recommended that—

(1) all irrigation should be stopped in or near British and Native lines ;

(2) all the ground should be levelled and drained where necessary, which must mean throughout the Cantonment ;

(3) all cultivation should be forbidden in the vicinity of barracks ;

(4) Regimental bazars should be reduced to actual requirements and placed "at a safe distance" (whatever that may mean) from the lines.

Recommendations couched in similarly drastic and equally general terms are very frequent, and I believe I am not wrong in saying that on the few occasions when an attempt has been made to carry them out, the result has been a great expenditure of money and the conversion of the station into a wilderness, but an absence of trustworthy evidence that mosquitoes and malaria have been markedly reduced.

But it is not only in regard to the problem of recommendations and advice that I think our present line of action is at fault. I think we fail also in regard to the application of the anti-malarial measures that are at present most usually recommended. I refer to the fact that in all, or in nearly all, the cantonments in the plains it is now the rule to make an attempt to destroy mosquito larvae, and to give quinine prophylactically. I am not competent of course to express a definite opinion to the effect that these measures are not in all cantonments necessary, but from a personal working knowledge of local conditions in most cantonments in India and Burma and from a study of reports and statistics, I gather that in the first place some cantonments are not at all malarious, and in the second that a number of malarious cantonments are so situated that any attempt to limit the number of malarial mosquitoes must be quite useless. Again I find it noted in the annual report of the Sanitary Commissioner with the Government of India for 1902 that "at Bellary, Shwebo, and some other stations, the medical officers stated that no anopheles mosquitoes could be discovered by

careful search, but that kerosine oil was nevertheless used as orders to that effect had been received". The fatuity of adopting measures against malarial mosquitoes when none of these insects can be found seems obvious, and on the whole the opinion appears justifiable that needless waste of expenditure arises from a general adoption in all, or nearly all cantonments, of measures which in the non-malarious cantonments appear to be unnecessary, and in some of the malarious ones appear to be futile.

Looking at the subject therefore from the spectator's point of view it seems to me that the present line of action is far from being the best that can be followed. What is wanted is a definite policy, and if possible, a centralisation of authority, so that research and practical measures can be systematically carried out upon a clear cut-and-dried, pre-arranged plan.

To start with it might be ascertained how much money—

(*a*) Government is prepared to contribute, and

(*b*) what sums cantonments can afford to subscribe towards anti-malarial measures.

Once this amount is known the whole question resolves itself into the solution of the problem how the money allotted can best be spent.

It is in these days of financial pressure not likely to be a very large sum that Government can give, and it will therefore be advisable to concentrate our efforts, for the present, upon the most malaria stricken cantonments.

Some cantonments are very malarious, others not at all malarious, and it would be absurd, at any rate at the beginning of the task, to spend money upon anti-malarial measures in the non-malarious stations.

When the stations where malaria is most prevalent have been decided upon, the plan of campaign will come up for settlement. To determine the best method of attacking the problem, it would, I submit, be desirable to form a strong central committee of practical men who would be aware of the relative importance of different cantonments, of the amount of money that might be available, and would possess the influence and the driving power necessary to enable any scheme which they approved, to be carried out as quickly as possible. The committee should include among its members, an adviser who has made a special study of malaria in India. When the committee had been formed it would endeavour to obtain the services of one or more competent medical officers who have made a special study of malaria in this country, and it would despatch these officers to the cantonments where malaria is most prevalent, with instructions to report upon them to the committee after consultation with the local authorities. These reports would be considered by the committee, who if it appeared necessary might submit them for opinion to any officer whom they considered well qualified to assist in the matter. The committee would then finally decide upon the scheme, which would afterwards be published for general information, and commenced without delay.

Each cantonment is of course a study by itself, and measures suitable for one may be quite inapplicable to the needs and local conditions of another.

The object would be to draw up for each cantonment a clear definite scheme that would meet with the approval of the committee.

It is quite likely that these expert medical officers would recommend in one or two cantonments the carrying out for a year or so of experimental measures. It is far better in the present imperfect state of our knowledge of this subject to spend money upon well considered measures of research, than to squander it upon ill-considered, half-digested schemes, which might end in failure.

Malaria has been with us for very many years, and a year or two spent in research by expert officers should not be grudged.

It is ridiculous to imagine that this disease can be stamped out suddenly. Any hurried, half-digested scheme is bound to involve a lamentable waste of money, and incidentally, loss of life.

If the policy which is very roughly outlined above were inaugurated, huge mistakes involving the useless expenditure of large sums of money could not be made, and we should have for each cantonment a definite scheme which could be at once proceeded with on funds being made available. In this respect the arrangements would be similar to those that are made in advance, in the event of war.

One advantage that this plan possesses is that it would automatically stem the devastating flood of recommendations by irresponsible individuals.

Everyone concerned would be aware that such and such was the scheme for such and such a cantonment, and that it was the plan to be carried out without any unauthorised deviations or alterations.

We should be saved the undignified and expensive situation created by inexperienced officers prevailing upon General Officers to attempt some pet scheme of their own, possibly against the experience gained by medical officers who have really studied the subject, and who are fully acquainted with all aspects of the problem in this country.

In the absence through illness of Lieutenant-Colonel Chaytor-White the following paper was then read by Mr. Ferard :—

Note on the propagation of Small fish as a means of limiting malaria

BY

LIEUTENANT-COLONEL J. CHAYTOR-WHITE, I. M. S.

In has been known for a long time that fish feed on the eggs, larvae and pupae of all kinds of mosquitoes, and this fact has been taken advantage of in many countries for the purpose of keeping down mosquitoes where they are found to be a nuisance. As a rule small fish are more suitable than large for the purpose, because mosquitoes breed in small, shallow pools and shallow places to which large fish could not gain access. Moreover small fish go into the shallows to escape being the prey of the larger fish. Fish that feed on the top of the water are most suitable for the purpose, but any small fish are useful. The United States Fish Commission in 1905 imported to the Hawaiian Islands a large number of top-minnows to get rid of the mosquito pest with favourable results. In the year 1905 a Mr. Kenrick Gibbons propounded the theory that the absence of malaria in Barbados was due to the fact that a small fish called "millions" abounded in streams and ponds in the island, and fed voraciously on the eggs, larvae and pupae of all sorts of gnats and mosquitoes. No anopheles mosquitoes have ever been found in the Barbados, while on the other hand, at the neighbouring island of St. Lucia and at Antigua, where there are no millions, anophelines abound. *Culex fatigans* and *stegomyia* are both found in Barbados as these two species, as is well known, will breed in small collections of stagnant water as tubs, sardine tins, concavities in trees and other places where millions cannot obtain access. The anopheles mosquito however breeds chiefly in shallow pools, streams and swamps. It is certainly remarkable that notwithstanding frequent close communication between Barbados and the neighbouring islands where malaria and anopheles exist, there is no malaria in Barbados, the only island where millions are found. The absence or presence of these fish appears to affect the existence of malaria. In August 1905, millions were introduced from Barbados into Antigua in a kerosine tin. They arrived in good condition and were kept in a tank and subsequently distributed. At the present time, four years since their first introduction, all the permanent collections of water have been stocked with millions and the planters have remarked on the cessation of the mosquito nuisance since their introduction. In Jamaica they were introduced in 1906 and fever has abated. This small fish, which has apparently acquired the name "millions" on account of the vast numbers in which they are found, so far as is known existed only in the island of Barbados, and has been technically identified as *Girardinus Pœcilóides* by De Filippi. They belong to the group of fishes known as top-minnows—minnows that feed on the top of the water. They are very small in size, the full grown female being only 1½ inches long, while the male is much smaller. The female is of dull colour while the male is marked with regular red splashes on the sides and has a circular black spot on each side. They live in shallow water among grass and weeds and are able to swim against a strong current. They

feed on all sorts of animal life, but particularly on the eggs, larvæ and pupae of mosquitoes. They increase in number very rapidly under favourable circumstances. Strangely enough, unlike most fish, the female does not lay eggs, but brings forth its young alive. They are viviparous. This fact was recently brought to my notice in rather a curious way. A medical officer in these provinces last winter asked his wife, who was in England, to procure some of these fish for him and bring them out to India. They all died but one which was placed in water in a glass jar. It was thought to be diseased as it had a very swollen appearance. The jar was unfortunately left uncovered and the fish was found later lying dead on the floor, having jumped out of the jar. The medical officer, however, dissected out the fish and, to his surprise, found it full of young, which under favourable circumstances would have probably sufficed to start the experiment in this country. It is really an advantage that these small fish should be viviparous, for, although the number of offspring from one female may not be so numerous as would be the case were the female oviparous, yet a larger proportion reach maturity as there are no ova to be devoured by predatory fish. The very small young may certainly be eaten, but they have a fair chance of escape.

I need hardly mention how greatly exposed the mosquito is to the onslaught of fish. The insect lays its eggs on the water and is probably frequently devoured while in the act of doing so. The eggs, for several days before they hatch, may be eaten, while the larvæ when moving from the top to the bottom to feed, and back again to breathe, are especially liable to attack. It will be cognizant to all how *chilwa* and other small fish during the monsoon are constantly to be seen jumping and feeding on larvæ in shallow pools near the roadside and in *jhils*. It is probably not so well known what merely a few fish can accomplish in this direction. Last September when mosquitoes were so bad and fever so prevalent, a gentleman in Agra put a few fish into the swimming bath there, with the result that the mosquitoes that had before been very bad entirely disappeared. Tadpoles apparently have little effect on mosquitoes as in a pool where there were some, anopheles abounded, while in another pool containing fish close by, no larvæ were found. Frogs and tadpoles do not eat larvæ though frogs will eat the adult insect.

Habits of feeding.—Millions have frequently been observed feeding on larvæ. They are probably the most active of all the natural enemies of mosquitoes and live for preference exactly in the localities and situations in which anophelines breed. They are most persistent in attacking larvæ and even very small fish will attack a large larva and keep hold of it till dead. They gorge themselves to distention with larvæ and will keep hold of a larva if unable to swallow it, until some of the food already eaten is digested and room is made for the latest capture. For most of the information about these fish I am indebted to the Imperial Department of Agriculture for the West Indies.

Propagation.—There is apparently no difficulty in introducing millions into new localities. As above noticed they have been successfully introduced into Jamaica, St. Kitts and Antigua. Dr. Chalmers Mitchell, Secretary of the Zoological Society of London, has had constant consignments sent him and they thrive excellently. I am sorry I have been disappointed in not having yet received a consignment as Dr. Mitchell writes, under date June 8th, 1909, that his own stock is at present very low and he has had to deplete it several times recently. The Colonial Office have, however, taken the matter up and propose introducing the fish into the Straits Settlements and have now a set of fish under the care of the Zoological Society for that purpose. The fish are easily fed and with the exercise of a reasonable amount of care can be successfully transported. I am arranging to receive batches and expect the first to arrive under the care of a medical officer this cold weather.

I take it that in India we cannot hope to do more than diminish the amount of malaria; to stamp it out, in the present state of our knowledge at all events seems impossible. Quinine, drainage, the filling up of pits and excavations and putting kerosine oil on tanks, are all excellent in their way, but we have to face the fact that we have here in India a heavy annual rainfall, and we have also constant excavation of earth going on, especially in villages for the repair and building of houses.

Malarial conferences hitherto have made a multiplicity of recommendations regarding mosquito extermination. They are costly—almost prohibitively so—if undertaken annually. Ronald Ross in his report on the prevention of malaria in Mauritius gives a list of recommendations for mosquito extermination that is sufficient to appal the stoutest heart and is impracticable of annual application. But nothing is said about the propagation of fish, and I consider that more should be done in this direction in India than has hitherto been attempted.

If we can do something that requires little human interference, that may be said to act automatically, that only requires the distribution of a few fish at the beginning of the monsoon and can then be left to itself to act, we at all events are doing something that does not cause much interference with the people, nor trouble or expense to a large community. In India we have annually large destruction of fish—the natural enemy of the mosquito. Yearly in the hot weather tanks and pools dry up and the small fish are killed off. These collections of water have to be restocked in the rains, and this is largely accomplished by the " wader " variety of birds that carry on their feet ova and small fry. Undoubtedly a good many varieties of fish burrow into the mud and keep alive throughout the dry weather. But it will be necessary to prohibit the natives killing off the small fish for food purposes, as they now do by netting tanks and pools when they become low. If we have a stock pond in each *tahsil* where fry can be obtained for distribution by *tahsil* chaprasis or others, restocking can be accomplished. I would encourage the breeding of indigenous fish such as *moila*, *kater*, *bhoor*, *rohu*, *tenghen*, *chilwa*, *perhin*, *jhinga*, *singhi* and *anwari* varieties. Top feeders such as the *anwari* (mullet) should be particularly useful for the object in view. All varieties of fish do not feed on larvæ and Lieutenant-Colonel Giles mentions in his book " Gnats and Mosquitoes " (page 150) that fish and mosquitoes are found together in the Madras rice swamps, but this is quite exceptional. That acute observer, the late Mr. E. H. Aitken, says in the same place : " From my experience I should say that, of all larvicides, the most effective in the case of anopheles, is little fish. I have never found larvæ and fish in the same pool. Once I put a large number of larvæ into two glass vessels and introduced a few gold fish into each. Next morning there was not one larva in either."

I suggest that the greater prevalence of malaria after dry years may be partly due to the great destruction of fry and fish spawn that occurs when the monsoon suddenly stops, as it did in 1907, inasmuch as the small pools and breeding grounds dry up, leaving fewer fish to breed in the succeeding year. Owing to the early cessation of the rains in 1907 as well as in 1908, the smaller varieties of fish were probably unusually scarce last year. As I have remarked fish spawn is largely carried on the feet of birds to other pools, and in a dry year this does not happen. The result is that fish are not so numerous as usual and mosquitoes increase and breed in large quantities. I had observations made last year which go to show that mosquitoes in some districts were unusually prevalent.

Anophelines will lay their eggs when hard pressed on very small collections of water or on mud, in which cases of course fish could hardly reach them. After all, as I have said, we can only hope to limit the amount of malaria, and anything that can tend in this direction should, I think, be encouraged.

The following discussion ensued :—

Colonel King said that some successful experiments with fish were made at Meiktila by Dr. Evers. He could not give any description of the experiment, but those interested could write to the officer who had conducted it, who was now stationed at Mergui.

Mr. Ferard referred to the question of " millions " spoken of in the paper and said that in this connection the oiling of tanks had been taken into consideration. He would like to hear, considering the difficulties in the matter, whether it would not be sufficient to oil merely the edge, or whether the entire surface should be oiled.

Surgeon-General Trevor said that as the wind blew the oil all over it was sufficient to oil merely the edges.

Major Rogers said: We have had a number of criticisms on the small amount of good done by anti-malarial measures in India. These works, and especially the failures, have never been put on record, and it is very important that the delegates should give their experience with reference to the measures that have been carried out in order to bring forward lessons derived from practical results.

For the past few years various measures have been undertaken in Bengal, the reports of which have not been made public, but have been placed at my disposal by the Bengal Government. From 1905 up to the present time experiments have been made in Bengal municipalities. On the advice of Major Clemesha, test work was done at Berhampore, the capital of the Murshidabad district, and recommended as being a suitable place. Colonel Nott, the Civil Surgeon, together with the Deputy Sanitary Commissioner, superintended the operations. They were carried out for two years, and it was found that a considerable reduction took place in the number of mosquitoes. The expenditure in two years amounted to Rs. 3,400 and the work consisted of filling up tanks, hollows and pools. It was watched carefully, but at the end of the second year the river which flowed on one side of the town changed its course to the other bank and left a large swamp; and this was accordingly held by the sanitary authorities to nullify the efforts made. This is a good example of the difficulties met with in attempting to carry out the proposed measures. Another experiment was made in Jogdispur in Bihar. This is a small municipality with an area of about a square mile. A European planter who took a great interest in the place superintended the operations. There was only a small number of tanks and irrigation channels. In this case they tried *leeping* and tarring the edges of the channels; that was not successful as the tar was washed away by the stream. After two years the experiment had to be abandoned because the mosquitoes were breeding in the rice fields all round. Here again the measures failed. A more continuous experiment was carried out at Ranaghat. It was selected as being a bad fever place, and as being probably the most favourable for an experiment in that part of Lower Bengal. Here the usual methods were carried out of filling up hollows and small tanks, together with oiling, and jungle cutting. These operations were superintended by the Civil Surgeon, and in three years a sum of Rs. 12,000 was spent, two-thirds in filling up pools and hollows. This was popular among the inhabitants, especially those who owned land, and much valuable land was reclaimed in this way. The ultimate result of this experiment was that it had no definite effect in reducing the malaria. There again it was found eventually that wet or rice cultivation which was found to be the chief breeding ground of mosquitoes, was being carried out within the municipal area. After three years' work the experiment was given up because it was said it would be necessary to carry out a drainage scheme. The drainage scheme is being worked out. At north Barrackpur there was another test, the idea being that as it was near Calcutta, it could be watched. At the end of two years no definite results had been attained.

These are very briefly the results so far, and I think some lessons can be derived from them. It is noteworthy that during this series of experiments no definite data were obtained as to the exact anopheles present which were carrying malaria. This was due to the fact that there was not the same Deputy Sanitary Commissioner two years running—there was no continuity. I wish to say a few words about the distribution of anopheles. My experience is that Anopheles *rossi* breed very largely in tanks in the hot weather, and we know that they have not been found to be malaria carriers. I have found that at the end of the rains, *A. fuliginosus* were breeding in *katcha* roadside drains. These are the chief malaria-carrying mosquitoes which have been found infected in Lower Bengal. Further, *A. fuliginosus* has been found to be infected by malaria both in the Punjab and in Bengal. This being so, it is not the tanks which are an important factor; at the end of the rains there are swarms of small fish in the tanks, but no anopheles. In Calcutta, which is properly drained, we find a large number of tanks but there is no malaria infection. The roadside drains are the important breeding grounds. I mentioned yesterday that long breaks in the rains allow of the anopheles breeding largely. As regards oiling the drains, the experiment was tried and found to be hopeless. At the end of a

week there were more larvæ than before the oiling. I believe that in Bengal the question of the permanent reduction of malaria is to do away with *kutcha* drains. We want to strengthen Sanitary Engineering, to work out levels in municipal towns; then to construct outfalls, give a grant if necessary for the purpose and extend the system of surface drainage, fill up these drains as much as possible, first in the denser parts of the town and then gradually throughout the whole area. It may be done gradually as funds allow. These permanent sanitary measures will have good effects. We have the example of the central parts of Calcutta, which was intensely malarial less than a century ago. Now there is no malaria there. This I am certain is the important question in towns and municipalities in Bengal.

As regards the question of the drainage of the sub-soil, I was speaking yesterday of the deltaic tract where areas are flooded throughout the rains, there harm may be done by drainage. This view is limited to that flood area. In the water-logged conditions that Captain Christophers has described, drainage by permanently lowering the subsoil water is, when practicable, of the utmost importance in reducing malaria.

Then as regards the question of rice cultivation in municipalities in many places in Bengal. We should prohibit this cultivation in the densely populated municipalities. In two of these test experiments anopheles were found in small pools as water subsided. This is a very important point. We should strengthen the hands of local Governments in carrying out these measures. It must be faced. In Ranaghat rice was only grown in a year when there was an unusual amount of rainfall, and rice cultivation might be done away with there. The essential measures to be adopted are to have permanent surface drains and to prohibit rice cultivation within a certain distance of a town.

Major Donovan explained that in certain parts of the Madras Presidency anti-malarial operations had been carried out but that they were not under proper control and it was therefore impossible to test the nature of the conclusions reported. What was wanted was a stronger staff to control and watch the results. Otherwise all attempts at improvement were likely to be wasted.

Mr. Goswami thought that all anti-malaria operations should be varied according to circumstances. As regards the Resolution which had been passed, he quite agreed with Colonel King's suggestion that the expert body of sanitary officers should be associated with men of engineering knowledge and that they should act in co-operation with a view of finding out if certain anti-malaria operations, involving large expense in the way of drainage, etc., were feasible or not. As regards the cultivation of rice near towns, it occurred to him that if people, especially in rural areas, were to undertake horticultural operations or plant fruit trees, they should be encouraged to do so and to give up the cultivation of rice. He would prohibit wet cultivation within municipal areas.

Colonel Dyson endorsed the opinion of Colonel King as to the importance of permanent improvement in the sanitary condition of malarious areas, aided meanwhile by certain palliative measures. Anti-malaria measures should be differentiated into those most suitable for towns and rural areas. In towns what was wanted was drainage schemes, the removal of water that was not wanted, and the like, whereas such measures would be costly, difficult of accomplishment and unnecessary in rural tracts, where quinine distribution would be of more value. In the Bombay Presidency, with the exception of quinine distribution in rural areas, the efforts made had been unorganized and spasmodic and left entirely to the local bodies concerned. There had moreover been a want of continuity. There were therefore few or no results to be chronicled. In Bombay the Sanitary Department was differently constituted to what he understood was the case in various other provinces. Excepting the Sanitary Commissioner and five Deputy Sanitary Commissioners, there were no recognized sanitary officers. There were inspectors of vaccination, but they had little or no sanitary training. He would suggest the embodiment of Colonel King's suggestion, or a modification of it, in a resolution. A definite statement should be added as to the staff required for carrying out anti-malarial measures.

Mr. Chaudhri said: The popular notion in the two Bengals is that insufficient drainage and high water level are the principal causes of malaria. I can say from my own experience that the silting up of the rivers Borat in Natore, Karatowa in Bogra and Lohajang and Jheenai in Tangait in Eastern Bengal and Assam are the chief causes of the water-logged condition of these places. Government seem to have accepted the theory of insufficient drainage and was actuated to introduce a Drainage Bill in Bengal. There is a difference of opinion among the experts at this Conference on the subject, and I am glad Colonels Leslie and King are in favour of drainage schemes. I think that instead of an experimental undertaking of the drainage of large areas, the cost of which will be highly prohibitive, it would be safer to undertake the drainage operations of only such highly malarial tracts where the subsoil water condition prevails, the cost of which will not be prohibitive and which do not involve danger to other localities. I may further suggest that Railway Companies and local bodies responsible for making roads and embankments should be asked to make borrow pits on one side only and not as at present on both sides and have the pits so dug as to cause a natural flow into the nearest river.

The President, referring to the statement made by Mr. Goswami as to the prohibition of rice cultivation in or near human habitations, said that in his experience it was by no means established that rice cultivation always produced malaria. In the province in which he had served most of his time there were areas where the ground was under water practically the whole year round; he could not recollect that these areas were markedly malarious. He did not think the suggestion made by Mr. Goswami of growing fruit trees would have the desired effect. Before they closed the sitting, it was desirable to arrive at some conclusion on the subject of measures of drainage. But before they could recommend to local Governments or the Government of India the undertaking of expensive measures of drainage, they should have more information on the subject than they possessed at present. He would therefore propose that they should recommend further enquiry into this subject.

Colonel King said the point was apparently that they should have some practical experience of what was best in India. With reference to what had been said in Captain Christophers' paper the question was, could the subsoil levels be kept within bounds or not. Experience on the subject was derived from various sources. The speaker then went on to refer to statistics given by a certain Board in America and to operations in Algeria.

The President explained that his point was that before any costly undertakings were begun it was necessary to prove that malaria was due to a high level of the subsoil water. He did not think the point had been established.

Major Rogers said: As regards the President's remarks as to rice cultivation not having proved to be harmful, I think it is simply a matter in Lower Bengal of whether rice grows in deep water which does not dry up during the autumn malarious months or whether the rice is grown on high ground in which case drying up occurs with mosquito-breeding during the malarial season. Thus rice which is grown on high land is most dangerous. Where the land is completely flooded up to late in the year it is most healthy. In Dinajpore there is the least malaria when the land is flooded until the temperature gets low, and the danger of malaria then ceases. That is why I consider that in these municipal areas, that is where there is a town population, this matter should be considered. I should like to propose the following resolution: That in municipal towns *pukka* surface drainage is a most important permanent anti-malarial measure, by removing stagnant surface water.

Captain Christophers: In Palwal, which is splendidly drained, there was a mortality from fever last year of 420 per 1,000. In that town drainage did not seem to make any difference.

Major Rogers: That is exceptional.

Captain Christophers: We know so little about these matters that it is difficult to say what is general and what special.

Major Rogers: The parts of Howrah where there is permanent surface drainage are now nearly completely free from malaria.

Mr. Fox-Strangways thought they should avoid spending money on any ill-digested schemes. At the same time, speaking as a layman, he would like to have something as a guide. He would like to support Major Rogers' suggestion that they should have from each province some information as to what had been done either in the way of drainage or anopheles extermination, etc., so as to know on what lines to proceed for the present, pending general operations. In the Central Provinces very little had been done. They had undertaken some measures of town drainage and in Nagpur and Jubbulpore they had allotted sums for outfalls and were gradually working out a system of street drainage. There was a general feeling that there had been an improvement in the health of the towns. In other towns there had been a somewhat half-hearted attempt at anopheles extermination, but there was a general consensus of opinion that mosquitoes had been gradually reduced. Figures showed that there had been a reduction in malaria. He would like information from other Provinces.

Colonel King thought it was necessary to have a definition of what drainage measures were. They had thought too much of subsoil drainage.

Colonel Dyson said that in Bombay Dr. Bentley found that the chief source of infection lay in the wells. It was generally considered that the epidemic of malaria in Bombay was due to recent operations in connection with Port Trust Works. There were undoubtedly large pools of water in which mosquitoes could breed.

Mr. Ferard, in reply to the request for information made by Mr. Fox-Strangways, said that new legislation was being considered on the subject of rural areas to admit of the draining of pools and tanks round villages. It would probably be embodied in the new Village Sanitation Act. As regards town drainage, all municipalities had been asked to prepare maps, with a view of carrying out brick or metal drains instead of *katcha* drains. There was also being undertaken the oiling of tanks.

Mr. Nathan thought the Conference should record nothing by way of mandate, but the attention of local Governments might be called to the drainage aspect of the question. Where it seemed possible that drainage would cause the reduction or abolition of infection, then the Sanitary Engineer element would come in and operations might possibly be carried out, but no general mandate whatever should, he thought, be given.

Colonel King agreed.

Mr. Mudholkar, to show the difficulties that District Boards have to face, gave the instance of Amraoti, where wells were abandoned and a water supply introduced. The health of the town did not improve, the reason assigned being that although they now had pure water to drink there was as yet no drainage system. A scheme of drainage costing about 1½ lakhs of rupees was therefore undertaken, but it was insufficient, and another scheme costing about 2½ lakhs was substituted. Finally a scheme was proposed which was estimated to cost 4½ lakhs. The town had a population of 35,000 and an income of from Rs. 50,000 to Rs. 60,000. If such schemes were to be proposed all over India the cost would be enormous.

Captain Baket drew attention to the fact that in Burma along the Railway line and Public Works Department roads there were thousands of miles of borrow pits.

Mr. Cholmeley said this must be a great factor in the breeding of mosquitoes.

Major Rogers' resolution was then submitted to the conference and accepted pending further discussion on the last day.

FOURTH DAY.

Friday, October 15, 1909

PRESENT.

Sir Harold Stuart, K.C.V.O., C.S.I., I.C.S., *President.*

The Delegates.

Before the proceedings began Colonel King, by permission of the President, made the following statement :—

With reference to yesterday's proceedings I would ask that the following facts affecting procedure be placed on record :—

The Chairman of the day ruled that discussion should be limited to measures against mosquitoes. Captain Christophers had read a paper, at the conclusion of which, whilst referring to drainage, he formally advised the employment of quinine. In my attempt to show that this conclusion of his otherwise admirable investigation was premature, I was interrupted by the Chairman (doubtless legitimately) on the ground of time. I subsequently desired to move a Resolution to the effect that " surface and sub-soil drainage are valuable anti-malarial measures ". In reply to protests by the Chairman, I explained that this Resolution was intentionally of a general nature, and was not limited by a definition of localities such as in the case of a previous Resolution, which advised the employment of surface drainage in municipalities. I respectfully hold that my proposed Resolution was appropriate, in that drainage is a measure of a radical and permanent nature directed against mosquitoes and therefore against malaria, that it had distinct reference to the papers discussed and to the Chairman's ruling, and that I was within my rights in endeavouring to secure a definite expression of opinion by the Conference on this most important branch of radical anti-malarial measures, desirable especially in the great centres of malaria as contrasted with palliative measures which, for financial reasons, are necessary elsewhere. The Chairman however refused to put my proposed Resolution to the Conference.

The President said that on the previous day as Colonel King had exceeded considerably the time limit allowed to each speaker he had suggested to him that his remarks should be brought to a close. In regard to Colonel King's proposed resolution it appeared to him that the first part was covered by the resolution upon drainage measures that had already been passed, and he ruled it out of order, but offered to put the second part. Colonel King, however, declined to accept this offer and withdrew his resolution.

Colonel Braide proposed that in order to allow more time for discussion the remaining papers should be taken as read.

The President put the proposal to the Conference and it was agreed that with the exception of Major Donovan's paper, which had only just been received, the papers for the day should be taken as read.

The following was the first paper on the programme :—

A summary of Anti-Malarial measures in the Punjab.

COMPILED BY

CAPTAIN C. A. GILL, I.M.S., UNDER THE DIRECTION OF THE INSPECTOR-GENERAL OF CIVIL HOSPITALS, PUNJAB.

THE devastating effects produced by malaria on the people of the province have long been a source of anxiety to the local Government and its medical advisers.

Amidst much that was ambiguous, two points have always been clearly recognised,—first, that malaria was extremely prevalent in the Punjab and, secondly, that it was especially common in low marshy regions and along the banks of those rivers (and their tributaries) which form so prominent a feature

of the provincial geography. As long ago as the early eighties the deleterious effect produced by inundations from rivers and canals on the prison population was so striking as to form the subject of a representation to Government.

At this time, however, the etiology and epidemiology of the disease were largely wrapped in obscurity ; for it may be recalled that it was not until 1880 that Laveran made the epoch-making discovery of the specific cause of the disease, and the agency of the mosquito in its transmission was not discovered by Ronald Ross until some 18 years later. Medical administrative measures must always wait on science, and it was therefore not to be expected that much could be attempted until our knowledge on these two cardinal points became more precise. The history of anti-malarial measures in the Punjab may, therefore, be divided into three periods, which follow, as they should, in measured tread the results of scientific research.

The first period may be said to end with the year 1900, the second to comprise the years 1900-1907, and the third—by far the most important—commenced in 1908 and deals with the state of affairs as we find it at the present time.

In regard to the period anterior to the year 1900, there is not a great deal to be said : the measures that were adopted were neither extensive nor important ; quinine was used both as a prophylactic and curative, but the extent to which it was administered depended more on the initiative of individual medical officers rather than organised effort. Thus it is of interest to note that the prophylactic use of quinine was tried on a small scale in the Delhi jail as early as 1887. Accurate knowledge of the extent and severity of the disease amongst the civil population was difficult to obtain, and it is therefore not surprising that it was in the jails, where efficient control and supervision could alone be exercised, that its terrible effect came first prominently to notice. The jail mortality was at this time high, and it was recognised and represented by the medical officers in charge that malarial fevers, though not actually responsible, were the main predisposing cause, and that if the disease could be mitigated or eliminated, a great reduction in the jail mortality would immediately ensue.

Actuated by these motives, it was decided in the year 1893 to carry out systematically the prophylactic use of quinine in all the jails of the province. This scheme, which constitutes the first systematic effort to deal with malaria in the Punjab, met at first with many difficulties and some opposition, but it has been steadily persevered with and improved, until at the present time the jail population possess a degree of immunity from malaria and a general healthiness in marked contrast to that of the surrounding population. Thus in 1890 before quinine prophylaxis was commenced, there were 11,934 admissions from malaria compared with 1,997 in 1908. Although the sanitary condition of the jails has been materially improved, nevertheless there cannot be room for reasonable doubt that the great reduction in the sickness and mortality in recent years is largely ascribable to the use of quinine.

The first attempt to deal with the civil population was in 1889, when the then Lieutenant-Governor, in consequence of a letter from the Reverend Mr. Carlton, a missionary, appointed a committee to enquire into the feasibility of reducing the extensive sickness and mortality in certain districts in the southern portion of the province. As a result of the deliberations of this committee it was decided to distribute quinine *gratis* in six districts of the Delhi division, and that district boards with the financial assistance of Government, should be encouraged to undertake such drainage schemes as were feasible. Accordingly, in 1890, free distribution of quinine in this area was undertaken, zaildars and village headmen being the chief distributing agency employed. In 1893 the scheme was improved and extended to other parts of the province, the distribution being carried out by district boards as well as numerous official and non-official persons. In 1892 the " pice packet " system of quinine distribution through the agency of the Post Office had been introduced in Bengal, and in 1894, on the proposal of the Inspector-General of Civil Hospitals, it was decided to extend this system to the Punjab. Accordingly, in 1895, with the sanction and co-operation of the

Postal Department, this method of distribution was inaugurated on an experimental scale in the Delhi division. It was, however, a failure, chiefly owing to the fact that free distribution was being carried out at the same time, and it was consequently abandoned in 1897. This is worthy of note as the danger of allowing the two systems to exist side by side is not without its lesson at the present time. In 1899 another and more successful attempt was made to introduce it into the Lahore and Delhi divisions, free distribution in these areas (except at dispensaries) being meanwhile discontinued.

The great advances made in our knowledge of the epidemiology of malaria in the closing years of the 19th century had the effect of causing further efforts being made to deal with the disease. These included not only quinine distribution, but also the carrying out in urban areas of simple measures of sanitary reform with special reference to mosquito extirpation. In 1902 the sale of quinine by Post Office agency was extended throughout the province, and in this and the following years efforts were made to popularise the measure and to spread knowledge amongst the people in regard to the self-treatment of the disease.

It must, however, be admitted that, judging from the sales that took place, the demand for quinine was at no time great, and the financial condition of local bodies, even with subsidies from provincial sources, was such as to preclude the inauguration of major sanitary works on a large scale. In 1904, however, 17 such schemes were approved by the sanitary engineer on the recommendation of the Sanitary Board, to which the local Government contributed a grant-in-aid of Rs. 19,148. In 1905, 15 sanitary works were inaugurated, the grant-in-aid from Government being Rs. 29,961. In 1906 Government made grants-in-aid amounting to Rs. 30,000 for 23 undertakings. In 1907, 11 schemes were sanctioned, the Government grant-in-aid amounting to Rs. 10,800; in 1908 Government contributed Rs. 69,078, and in the present year the grants have been increased to treble this amount. In 1907 quinine prophylaxis during the months of August, September, October and November was introduced into the police force and carried out for the first time.

Such was the state of affairs on January 1st, 1908, which marks the commencement of the third and most important period in the history of anti-malarial measures in this province. On May 11th, 1908, the Inspector-General not being satisfied with the progress made in combating the disease, addressed Government on the subject, and formulated proposals for popularising and extending anti-malarial measures in general and quinine distribution in particular. These suggestions were received with marked approval by the Lieutenant-Governor, who, being greatly impressed with the importance of the subject, desired that even greater efforts should be made to deal with the formidable evil. The result was that the following measures were adopted :—First in order to increase the interest of postmasters in the sale of quinine and to stimulate them to greater activity the commission allowed on the sale of each packet of the drug was increased from 2 to 4 annas ; secondly, the basis of distribution was greatly widened by enlisting school-masters, native druggists, holders of licenses from the Excise and Stamp departments, as agents for its sale. Another important new departure was the establishment of a central agency to control the distribution of the drug. This was taken out of the hands of the jail department, to whom it had been entrusted in 1902, and placed under the direct control of the Inspector-General of Civil Hospitals, who was supplied with a special staff for the purpose.

The need for these measures was only too well exemplified in the following autumn, when the Punjab was visited by an epidemic of almost unprecedented severity. Its extent can be to some extent appreciated from the fact that the mortality from malaria was in round numbers 700,000, compared with 400,000 in the preceding year, thus giving a death-rate of 34·66 *per* 1,000 instead of 19, which is roughly the average of the previous four years.

But even this enormous mortality affords but a feeble indication of the amount of sickness, with its concomitants of misery and poverty, that prevailed. It has been estimated that in some districts 90 *per cent* of the population were at one time or another afflicted with the disease during this period.

Labour was seriously disorganised and the price of foodstuffs throughout the province ruled high. The far-reaching effects of the epidemic are well exemplified in the case of the North-Western Railway, where, owing to the fact that many of the staff were incapacitated, the train service had frequently to be suspended to the great financial loss not only of the department, but also of commercial and agricultural interests generally.

To meet the emergency extraordinary measures were necessary and were promptly adopted. Quinine was distributed free of charge on a large scale; over 6,000 pounds were disposed of by the central agency alone. The plague and vaccination staff were requisitioned to distribute the drug and afford medical relief to the people. Four itinerating hospitals in charge of hospital assistants were despatched into the most severely infected areas, where they administered relief to 17,136 persons. In addition to these four others were organised by the district board in the Lahore district. Finally local bodies were encouraged to buy large quantities of quinine on the understanding, which has since been realised, that Government would indemnify them of all expenditure incurred in this manner.

After the epidemic efforts were redoubled and the whole question was considered in the light of recent experience. The channels of distribution were defined and endeavours were made, while preventing overlapping, to elaborate a network all over the province whereby quinine could be easily and cheaply placed within the reach of every person wishing to obtain it. The scheme is not yet in all particulars complete; but the great measure of success which has so far been attained is largely due to the great interest and enthusiasm of the Lieutenant-Governor, who has practically caused the whole machinery of Government to be brought into play to give effect to this policy

The following are the most important measures that at present have been adopted :—

(1) Two "Eureka" tablet-making machines capable of turning out 25,000 tablets a day have been purchased and are now in use in the Lahore Central Jail.

(2) The question of stocks and storage has been satisfactorily settled and a large reserve of quinine has been provided to meet emergencies.

(3) To bring the drug within reach of the rural population the following procedure has been laid down :—

(*a*) *Distribution on payment.*—This is carried out by the central agency alone. The drug is supplied either in tablet or powder form to postmasters, schoolmasters, patwaris, native druggists, holders of licenses from the Excise and Stamp Departments, and any other respectable persons recommended for this work.

(*b*) *Free distribution.*—This is carried out by the local agency. It is the duty of district boards and municipalities to supply the drug to the dispensaries under their control and to zaildars and others for distribution to those who are unable to purchase it for themselves.

(4) Efforts have been made to spread knowledge in regard to malaria by the issue of a pamphlet in Urdu and Gurmukhi entitled "Malaria and how to escape from it" to all zaildars and others in the province. Arrangements are being made to paste a leaflet on the cover of books used in schools giving a few simple facts about malaria, and, lastly, the plague staff have been ordered to utilise every opportunity of spreading knowledge about malaria amongst the rural population.

(5) The formation of 30 itinerant hospitals to be kept as a reserve to meet emergencies have been sanctioned, and they are in process of formation.

(6) To meet the case of officials and Government servants, the following measures are in operation:—

(*i*) Quinine prophylaxis, as already stated, is carried out during the fever season in the jails and in the police force throughout the province.

(*ii*) Government servants drawing less than Rs. 10 a month are provided with free issue of quinine, which they are required to take once a week during the period from August 15th to November 15th each year. Persons who refuse to take the drug without adequate reason may be put on general instead of casual leave at the discretion of the head of their department, if they require leave of absence on account of malaria.

(*iii*) A free issue during the same period is also given to the establishment of settlement officers.

(7) For some years quinine has been distributed more or less widely amongst employés of the North-Western Railway, a special stock of the drug belonging to the railway being kept at Lahore for the purpose. During the current year this has been systematised, and steps have been taken to carry out adequate quinine prophylaxis for all railway employés in the province during the fever season.

Another measure which it is intended to adopt shortly is the reduction of the price of the packet of quinine (containing 102 powders) from 1-5-6 to 15 annas. This measure, which has only recently become possible owing to the market price of the drug having fallen, will, it is hoped, tend to considerably increase its sale. It is also intended to supply the drug in tablet form instead of the powders now in use. This arrangement has been found to be exceedingly satisfactory, as not only is the drug much appreciated in this form by the people, but it ensures accuracy of dosage and prevents adulteration. It is expected that it will be possible to issue the drug in 5-grain tablets at the cost of one pie each, or three tablets for one pice.

To further popularise the sale of quinine and spread knowledge in regard to malaria, it is intended at the forthcoming exhibition to be held in Lahore to display samples of cinchona bark and to have quinine on sale in both tablet and powder form. It is also proposed to show the tablets in process of manufacture, and lastly, but by no means least, it has been decided to erect two houses, one built in accordance with the plan commonly adopted in villages and the other modified in order to conform to the elementary principles of hygiene.

Much has been said in regard to quinine. Its importance indeed cannot be overrated. It may therefore be not out of place to mention that as a result of experience the following principles have been adopted in regard to it :—

(1) Quinine, except in the case of emergencies or to the very poor must not be supplied free of cost, for it has been found most desirable on many grounds that a small, if merely nominal, price should be charged for it ;

(2) The sale of quinine by all agencies should be at a uniform price ;

(3) When quinine prophylaxis is carried out, it is desirable that the procedure should be as simple as possible with due regard to efficiency, and it is therefore recommended that the drug should be exhibited in full dose on one day each week.

Conclusion.

While laying the greatest possible stress on quinine, the medical advisers of Government have been careful to point out that other measures must not be neglected. Quinine is but a temporary measure, and it is not by the use of this drug *alone*, even if it were possible to administer to the whole population, that malaria will ever be banished from this province.

In addition to measures of sanitary reform and drainage schemes aiming at mosquito extirpation there is an urgent necessity for the gradual introduction and enforcement in towns and villages of regulations calculated to promote a higher standard of living amongst the people. It is impossible to overrate the value, in the lessening of disease generally, of the observance of a few elementary rules of domestic hygiene and personal cleanliness. In the crusade that has been inaugurated in the Punjab these measures have therefore been considered, but the manifold and manifest difficulties which they present militate against their hasty adoption, and for this reason nothing has so far been done, and it has therefore been necessary to lay great emphasis on the value of such measures as quinine which are capable of immediate adoption. But even the latter measure, it must be remembered, is by no means free from difficulty. In the past the high price of the drug and small supply available would have prevented its use in large quantity even if there had been any demand for it. This state of things has, as regards the Punjab, happily disappeared. The price of the drug has decreased from Rs. 15 per pound in 1905 to Rs. 7-14-0 per pound at the present time. The provincial Government and local bodies are free to obtain it in the cheapest market, and there is thus a practically unlimited supply now available.

The only remaining difficulties rest with the people. There is still a good deal of prejudice against the use of the drug, which though not insuperable, will require a good deal of time and patience to overcome.

Quinine is unfortunately considered a "hot" medicine, and therefore unsuited to a disease like malaria, which is attended with high fever. There is also an idea prevalent amongst even educated Indians that its exhibition must be accompanied by large quantities of milk.

These difficulties can only be met by education and experience, and in this connexion it may be hoped that the Malaria Conference will issue some authoritative statement calculated to remove apprehensions of this nature from, at any rate, the minds of all educated persons.

Finally, it has been the desire of Government, in giving effect to these measures for promoting the health and prosperity of the people, to avoid either hasty action or undue display of anxiety lest unwittingly the easily excited suspicions of the people should be aroused in regard to their beneficent intentions.

The following was the next paper :—

Problems relating to the use of Quinine

BY

MAJOR S. P. JAMES, I.M.S.

Before commencing an attempt upon a considerable scale to combat malaria in India by the widespread employment of quinine, it is obviously advisable to make a thorough study of many problems connected with the drug, and therefore I have thought it would be useful to summarize briefly our knowledge in regard to some of those problems and to indicate some lines of investigation that should be followed in this country. Very little work upon quinine has been done in India, and although in our hospitals generally the results of using the drug according to the routine methods described in text-books are good, it often happens that the time taken for the cure of malarial patients is unduly long, the amount of quinine used is unnecessarily great, and a number of cases occur in which the drug appears to be quite inefficacious. Many failures to prevent attacks of malaria by the use of quinine, especially among British soldiers, are also reported, and there is no doubt that in the near future such reports will become increasingly numerous. Failures of this nature would be very detrimental to the success of an attempt to popularize the use of quinine in India and it is therefore necessary that we should by careful research ascertain the causes

of failure and guard against them. It can be laid down at once that, since quinine is known to be fatal to the malaria parasite, the cause of failure in its use is due not to the drug but to a want of knowledge regarding the correct way to employ it, and it would therefore be of great advantage if as a result of a well arranged plan of investigation we could obtain such knowledge as would enable us to formulate improved rules in regard to (1) the doses of quinine that should be employed in order to cure the disease in the quickest time and with the least inconvenience to the patient; (2) the proper times in relation to the access of fever at which the doses should be given; (3) the best salt of the alkaloid to employ and the best mode in which to administer it; (4) the best plan of using the drug for prevention.

Many attempts to answer these questions have been made in Europe, but the results obtained by different observers are very contradictory and we have no guarantee that what applies to European patients will hold good for natives of India—indeed knowing as we do from Captain McCay's researches that the composition of the blood of non-flesh eating natives of India differs considerably from that of the blood of flesh eating Europeans, and that in all probability the processes of absorption, metabolism and elimination also differ considerably in the two classes of people, it is essential that we should not be content to rely upon European experience but should study the matter thoroughly for ourselves.

The all-important object of such a study would be to obtain knowledge that would enable us to draw up improved rules for treatment and prevention, and in regard to this the first matter upon which we require further and more definite information is the action of quinine upon healthy natives. Before we can allow ourselves a free hand in distributing the drug for indiscriminate use without medical supervision we should be satisfied that the results of such use cannot be otherwise than beneficial. Our knowledge of this subject is too slight to enable it to be discussed adequately. We are aware that the deficiency of hæmoglobin in the red blood corpuscles of natives of India renders their oxygen carrying power less than that of the red blood corpuscles of Europeans and that large doses of quinine may be deleterious, as Binz has shown, by binding the oxygen more firmly to the hæmoglobin thus further inhibiting the oxygenating power of the blood. It has been said also that the administration of certain salts of quinine tends to lessen the power which the red blood corpuscles have of resisting hæmolysis. Captain MacGilchrist has lately made some interesting observations on this subject. The effect of large doses of quinine upon the leucocytes has also to be investigated more thoroughly, but so far as we know at present the administration of such doses does not lessen their phagocytic activity or mobility. On the whole I think that, although there is no definite evidence that large doses of quinine are harmful and much evidence that such doses are harmless, it will be agreed generally that for both hygienic and economic reasons a prime object of investigation should be to ascertain the *minimum* doses that are effective in treatment and prevention respectively.

In the second place we require further study of the action of quinine upon different stages of the malaria parasite. If quinine were immediately fatal to all forms and stages of the parasite the treatment of cases would be exceedingly simple, and deaths of malarial patients who had received quinine would be almost unknown. Unfortunately the matter is very complex, the success of the drug depending upon a number of factors about which we know little or nothing at present. The time of administration is all important because we know that the drug is immediately fatal to only one stage of the parasite, namely, to that stage which follows sporulation. Upon all other stages it is either entirely inoperative (*e. g.*, upon the sexual forms) or acts in a manner that may make it entirely wrong to give the drug at a time when it will act upon such stages. For example it is the experience of nearly all observers that quinine given when the blood contains only endoglobular parasites often prolongs the paroxysms of fever and may convert a simple definitely intermittent fever into one that is almost continuous. Also it is now nearly 20 years since Marchiafava and Bignami pointed out that if large doses of quinine are given when the blood contains only pigmented parasites in process of development, the result

may be the appearance of numerous sexual forms of the parasite instead of the usual asexual forms. This phenomenon of the abundant formation of gametes after large doses of quinine has been again observed and written about quite recently in Italy, and I think it quite possible that in this country the common observation of numerous crescents in the blood of European soldiers who are being treated with large doses of quinine is also an example of it. In Mian Mir last year crescents were exceedingly numerous in the blood of European soldiers who were receiving considerable amounts of quinine once or twice a week, and in this respect the examination of their blood yielded results which were very different from those obtained in the examination of the blood of untreated natives. In the blood of the latter it was rare to find crescents. Relapses of fever which almost certainly were brought about by the development of the female crescents parthenogenetically were also exceedingly frequent among the European troops and it appeared doubtful whether the large doses of quinine at intervals of a week had any effect in preventing these relapses. It is possible therefore that by administering large doses of quinine more or less in a haphazard manner we may not only be placing the patient in such a condition that he is very liable to relapses but may be increasing enormously the sources from which anopheles mosquitoes become infected. This possibility is worthy of serious consideration and investigation. Another problem which requires to be worked out thoroughly is the action of quinine upon the flagellated parasite. We know that the drug is inoperative upon crescents in the human body—that is upon crescents that are surrounded by the protecting envelope of the red blood corpuscle—but we do not know what might happen to a crescent that was subjected to the action of quinine after it had reached the stomach of the mosquito—that is after it had escaped from its protecting envelope and had become a flagellated parasite. One can scarcely imagine that the microgametes (flagellae) could survive the action of even a minute quantity of quinine and if this were the case it might be possible so to arrange our treatment of a patient whose blood contained gametes that he would be non-infective. Any one who has observed how numerous are the gamete forms in the blood of some European soldiers will realise the importance of this matter. I am aware that the formation of zygotes in the stomach of a mosquito that has sucked blood from a patient who was undergoing quinine treatment has been reported, but the interpretation to be placed upon this result depends entirely upon whether quinine was or was not present actually *in the blood* of the patient at the time he was bitten by the mosquito. I shall note later that although quinine may be present in the body for a considerable period, its length of stay in the peripheral circulation is probably exceedingly short, and that in all probability the only way in which we can keep some of the drug in the circulation is by giving doses at frequent intervals. There are other problems of importance in this connexion but a consideration of them would lead us too far astray from our present purpose. On the whole we see that the problem of the action of quinine upon the different stages of the malaria parasite urgently requires further study, and that in the present state of ignorance it is perhaps unwise to attempt to attack any stage of the parasite except that very vulnerable stage which immediately follows sporulation. It is reasonable to suppose that a very small amount of quinine suffices to kill that stage and it may well happen that having discovered the minimum effective dose for that purpose and the exact time in relation to the access of fever at which it should be given, it might be advisable to change entirely our present routine methods of treatment.

But even in the attack upon the vulnerable stage we have still much to learn before we can consider ourselves upon sure ground. We must know first as regards the parasite (1) in what parts of the organism does sporulation occur and does it occur in any positions which cannot easily be reached by quinine? (2) how long before the beginning of fever does sporulation commence? (3) how long does it last? and second as regards quinine (1) do we require the drug to be present in the peripheral blood or in the internal organs or in both? (2) how soon after administration by different methods will it be present in the parts of the system where it is required? (3) when will its action in these situations be greatest? (4) how long will it remain there? (5) in regard to these points what are the

differences according as we administer large or small doses and according as we administer the amount in a single or in divided doses? (6) what is the smallest dose that will be sufficient to kill all the young parasites of a given generation? (7) what are the differences in the use of the drug for adults and for children? (8) what are the differences according as we administer the drug by different methods? and (9) what is the relative value of different salts of the alkaloid and of different ways of dispensing it?

Very few, if any, of these questions can be answered without further investigation of the physiological chemistry relating to the absorption, metabolism and elimination of quinine by the human body. In Europe a considerable number of experimental observations upon some of the subjects have been made but it is very necessary that they should be repeated upon natives of India and extended in many ways. The following are among the more important results obtained in Europe:—(1) Quinine when administered by the mouth is absorbed chiefly in the stomach and small intestine. Absorption is very rapid and very complete and observers generally are agreed that preparations of the drug which are insoluble in water are absorbed as completely, if not quite as rapidly, as the most soluble salts. By far the greatest proportion of the quinine administered is absorbed during the first six hours after administration, but the process is less rapid if the drug is given on a full stomach. (2) From the alimentary canal the drug passes into the blood but on account of the great difficulty of detecting quinine in the blood, we know almost nothing about the duration of its stay or about the way it is carried in that fluid. In an endeavour to detect quinine in the blood. Giemsa and Schaumann made a number of experiments upon animals and were able only once to prove its presence in the blood of a dog to which lethal doses had been administered. In this instance the quinine was found in the blood serum only—the red corpuscles being proved to contain none. These observers concluded that from the alimentary canal the blood can take up only very small quantities of quinine at a time, and that what is taken up is either quickly destroyed or quickly deposited in the organs. They consider that this is the only hypothesis on which we can explain the fact that although a considerable amount of quinine is present in the urine very shortly after administration only very small traces of the drug can be found at any given moment in the blood. If their results in regard to the quick disappearance of quinine from the blood are correct, they indicate the paramount importance of ascertaining the exact time at which the drug should be administered in order to secure its presence in the blood during sporulation. (3) Whatever may be the quantity of quinine that is present at any given moment in the blood, and whatever may be the length of its stay there, it is fairly certain that a large proportion of what is administered by the mouth quickly becomes deposited in various organs, chiefly the liver, gall bladder, kidneys, suprarenal bodies, brain and spleen; and that in these organs, but chiefly in the liver, the quinine molecule is split up and the drug destroyed. According to Mariani the amount of quinine thus used up in the body is about 33 per cent of the amount administered and according to Giemsa and Schaumann about 66 to 75 per cent. I am not prepared to say whether the quinine that is thus stored up and metabolised in the organs takes a part in the destruction of parasites or not. Most authors consider that the only useful portion of a dose of the drug is that which, having escaped destruction in the organs, passes through the circulatory system and is ultimately eliminated in the urine; others consider that the amount of quinine that the blood can contain is so small and the length of its stay in that fluid is so short, that we must regard the whole action of destruction of parasites as taking place in the organs, in which case the quinine deposited in those viscera would be all important. It is obvious, of course, that a considerable portion of the quinine that is absorbed from the alimentary canal and passes by the portal vein to the liver, where it is destroyed, never gets into the general circulation, and according to Plehn the advantage of giving the drug subcutaneously lies in the fact that when so given it has to circulate for an appreciable time before getting into the liver where it is destroyed. (4) The quinine that is not destroyed in the body is eliminated in an unchanged condition in the urine, the amount so eliminated being usually about 25 to 33 per cent. of the amount administered. Hardly any is eliminated in the fæces and none in the sweat. We cannot regard the amount eliminated as a

measure of the amount that has been absorbed nor can we consider the period of elimination as an indication of the period during which the drug is present in the blood. But the rapidity of absorption and elimination is indicated by the fact that Lewin found traces of quinine in the urine from 13 to 17 minutes after the administration of a soluble salt of the alkaloid, and Giemsa and Schaumann found the drug 25 to 30 minutes after administering the pure alkaloid which is exceedingly insoluble. Elimination is greatest during the first six hours after administration and although faint traces can be detected for three days it may for practical purposes be considered as being concluded in 24 hours. This is also the period during which elimination lasts when the drug is given subcutaneously. The percentage of quinine eliminated differs according as the drug is administered in a single dose or in small doses frequently repeated, and it differs with the administration of soluble or insoluble salts, but the correct way in which these results should be interpreted is by no means certain.

So far as anything useful can be obtained from these results, I think the most important indication is afforded by the statements relating to the quick absorption of quinine and its quick disappearance from the blood. These show that the time of administration is all-important and that our efforts should be directed to securing a more lasting action of the drug rather than to securing the administration of larger doses than are at present given. Clinically it has been shown that the administration of the drug in small doses frequently repeated is more efficacious than administration in a single large dose, and it would seem that until we have fuller and more accurate information, the repetition of doses at short intervals is the only plan by which we can ensure that the drug will be in the blood whenever forms resulting from sporulation appear and will continue to be present throughout the whole period during which sporulation lasts. The method is an old one, but under the name of Nocht's fractional method of treatment it has been recently reintroduced and employed with excellent results by a number of observers. It should certainly be adopted for extensive trial in this country. In regard to the so-called " after treatment " of patients it may be noted that in view of the possibility that the formation of gametes may be increased by administering comparatively large doses of quinine once or twice a week, Celli considers that after the actual attack of fever is over we should reduce greatly the daily doses of quinine and should not attempt the almost impossible task of quickly eradicating the parasites by the continued administration of large doses. For the prevention of the disease it must be recognised that it is all-important to kill the injected sporozoites before they have had time to get into the fortress of the red blood corpuscles. If once we allow the parasites to proceed unchecked through several asexual generations, difficulties arise which are not easily overcome. A very small dose of quinine suffices to kill the sporozoites, but it is obvious that in this matter, as in treatment, the time of administration requires chief attention. A common prophylactic method is to take a few grains of quinine every morning, but in view of the quick absorption of the drug and its rapid disappearance from the peripheral blood it may well be that a dose taken, say at eight in the morning, would be useless by 12 o'clock the same night. If this is the case it is evident that since protection is required only during the night we should take the prophylactic dose in the evening. Attention to such a simple matter as this might make all the difference between success and failure.

We see, then, that from the data provided by the experimental work summarized here we arrive at two very important results, namely, (1) the best *routine* method of treating malaria is to administer doses of quinine at frequent intervals, and (2) the best method of using quinine for the prevention of malaria is to take a small dose every evening. But while I submit that in the present state of knowledge these principles should be followed in any scheme for extending the use of quinine in India, I do not bring them forward as a final solution of the problem. I trust also that no one will consider that I believe good results cannot be attained by other plans. For example it is impossible to doubt that in the Punjab jails last year the administration of 15 grains of quinine once a week was an exceedingly effective method, and among both prisoners and soldiers other almost equally striking successes by that method have been recorded. I take leave also to guard myself by saying that although the experimental work here recorded

enables us to explain very simply and easily the causes of most of the reported failures to diminish malaria by the use of quinine, we have at present in India no observations by which the accuracy of that experimental work can be verified. This being the case I need hardly say that I have recounted the work in order to show that even upon the subject of quinine, about which there ought to be a mass of accurate information, there is in reality extremely little, and that even upon this subject it is urgent to initiate further investigation. One desires also to combat the absurd view held by some critics in England to the effect that all the really useful knowledge about malaria and the methods of preventing it has been discovered, and that instead of occupying ourselves with trying to find out the value of those methods and the correct way of applying them, we ought long ago to have begun to carry them out blindly, here, there, and everywhere, regardless not only of expense, but of every other consideration that might quite naturally occur to a rational person.

The following paper was read :—

The most useful salt of Quinine for general distribution in Malarial tracts

BY

MAJOR C. DONOVAN, I.M.S.

I propose to read a short paper on this subject, embodying my experience of the use of quinine in powder, and not in solution, in the treatment of malaria.

I shall take up the subject under the following heads :—

1. Quinine sulphate in powder, in doses of 7 to 10 grains, and taken without solution in dilute acids, is generally useless. The solubility of this salt is 1 in 800 of water.
2. Quinine hydrochloride, a much more soluble salt, 1 in 30 of water, does not give, in doses of 5 to 10 grains in powder, universally satisfactory results. On the whole it is far preferable to the very insoluble sulphate.
3. Would the production of the hydrochloride be feasible in the Government factories, and, if so, would the cost of its preparation, in comparison with that of the sulphate, be prohibitive for general distribution among the populace ?
4. Results of dosage of the very soluble salt, acid hydrochloride, soluble 1 in 1 of water, given in powder are very much more satisfactory than the preceding two salts of the alkaloid. But it is feared the cost of preparation would be prohibitive.
5. Summary and precautions on the indiscriminate use of quinine in general.

Before taking up the separate headings, I may say that the results I am about to formulate have been derived from observations made at the General Hospital, Madras, since the year 1903, a period of five years excluding a year and a half I was absent on leave. The total number of cases of malaria that came under attention aggregated 429. The number appears small but I may mention that all these cases were most carefully studied during their stay in hospital. I do not include in this category numerous other cases of paludism that were observed by me in and out of hospital during the last 18½ years. In 1903 I started demonstrating to my students the futility of giving quinine in powder. Again, it is not to be presumed that I have dosed my 400 and odd hospital patients with quinine in powder ; a very small quota have been subjected to this mode of treatment, roughly speaking about 50 in all.

1. Sulphate of quinine taken in powder in the usual dose of 7 grains as supplied by the Post Offices I found useless. I have on several occasions, when patients were suffering from benign malaria and with their full consent, given an

object lesson to my students of the uselessness of giving quinine undissolved in dilute acids. The results were in all cases checked by microscopical examinations of the blood.

2. Hydrochloride of quinine in powder in doses of 5 to 10 grains gave better results, as was to be expected; but here again disappointment was occasionally met with.

3. The hydrochloride, as it gives better results than the sulphate, would be the salt to distribute among the general population of malarious areas, especially in the form of tabloids containing 10 grains of the salt and 1 grain of citric acid. I would ask for information regarding the feasibility of the production of the hydrochloride in India.

4. The results with the very soluble salt, the acid hydrochloride, are doubtless good, though occasional cases resistant to its powerful action have been observed. The cost of this drug places it, I fear, beyond the reach of general use.

5. To summarise, I may say that I have very little faith in the use of quinine powder given in ordinary doses. On the other hand, there is no gainsaying the results obtained by the exhibition of the different salts in solution in dilute mineral acids. I usually employ for a dose 30 grains of the sulphate, or 20 grains of the hydrochloride or 10 grains of the acid hydrochloride, dissolved in a dram of dilute mineral acid, sulphuric or hydrochloric, in about 2 to 3 ounces of water.

I always administer quinine in solution by mouth and rarely am I forced to resort to the hypodermic method. My hospital and general practice have taught me to place no reliance on intra-muscular injection of quinine, hypodermic or subcutaneous injection is nearly on a par with giving the alkaloid in powder by the mouth.

Intra-muscular injections do act, but the action is decidedly slow. In a case of chronic malaria that had been injected by quinine in the buttock and back twice a week for nearly a year, I have removed the unabsorbed quinine, loosely speaking, in handfuls, from the ulcers caused by its presence in the tissues.

I finish this very brief paper with a word of warning as to the indiscriminate use of quinine for long periods; it is a potent drug for good and evil. It is not to be forgotten that permanent damage has resulted by the misuse of the alkaloid for a long time, for instance, permanent deafness, defects of vision, etc. And last, but not least, though happily on rare occasions, the occurrence of tetanus resulting from hypodermic injection of quinine must not be overlooked. I hope my paper will result in a useful discussion on the merits and demerits of giving quinine in powder for the use of the general population of the malarious tracts in India.

The following discussion ensued :—

Colonel Lukis said that he had read with great interest Major James' valuable and instructive paper. There was no doubt whatever that quinine was fatal to the malaria parasite but he proposed that the Conference should pass a Resolution to the effect that careful experiment and investigation was necessary with the object of formulating definite rules :—

(1) as to the proper dosage of quinine,
(2) its time for administration,
(3) the best salt of quinine and the most suitable method of administration,
(4) the best method of using it for prophylactic purposes,
(5) as regards the class of cases in which the use of quinine was inadmissible.

Such investigation, if carried out by properly trained observers, he regarded as being at least as important as the one that had already been decided upon with reference to the mapping out of fulminant malaria areas. As regards (5) the reasons for the proposal were that every practical physician was fully aware

that there were many cases of malarial origin in which quinine did more harm than good and the stoppage of the quinine led to a disappearance of the fever. Major James had alluded to this point in his paper. Further investigation was necessary. There was also the very important question of the relationship between quinine and blackwater fever.

He wished to offer a few remarks with regard to the practical difficulties regarding quinine prophylaxis and in so doing he would divide the subject into two heads—

(1) quinine prophylaxis as it concerned people under discipline, soldiers, prisoners and the like, and

(2) quinine prophylaxis as it concerned the general public. In the first case they were dealing with bodies of men who were bound to obey orders and they did not encounter the difficulties which beset the administration of an unpalatable drug to children. Therefore there was only one point in this connection on which he desired to lay stress. This was one to which Major Donovan had drawn attention ; when quinine was administered as a prophylactic to soldiers or prisoners the drug should be given in solution. Unless this were done it would not be possible to get any reliable deductions from the results ; for three very good reasons :—

(1) most quinine tabloids, unless they are perfectly fresh, become hard and are thus apt to pass through the bowels unchanged like pebbles ;

(2) even if the tabloid be a soluble one we can never be quite sure that it would undergo solution in the stomach, if taken when the stomach was full of food or if the patient be suffering from dyspepsia. The quinine would then pass unchanged into the intestines and the result would be delay in its absorption ;

(3) if the drug were given in solution, one could be perfectly sure that it would be swallowed, whereas a tabloid could be concealed and be then disposed of, which was not an infrequent occurrence.

The next was the important question of prophylaxis as it affected the general population. In this case one had to deal with people who were free agents and need not take the quinine unless they wished to do so. They were met with four very serious difficulties :—

(1) A very large number of Indian patients are averse to the use of English medicines, and they have a strong prejudice against quinine which they consider has heating properties and is therefore unsuitable for the treatment of febrile diseases.

(2) An Indian regards a medicine as something to be taken only when ill. He has no knowledge of prophylaxis and it is often impossible to persuade him to take medicine for that purpose.

(3) It is extremely difficult to administer quinine to children, who are the chief disseminators of malaria ; this difficulty is particularly great when dealing with Indian children.

(4) In this form of prophylaxis it is not possible to administer quinine in solution ; it has to be distributed in solid form and one could not be sure of getting the full value of the drug. If the quinine prophylaxis, as it concerned the general population, was to be successful in any given area, four things would have to be accomplished :—

(1) It is necessary to overcome the prejudices of the public against English medicines, especially quinine.

(2) They should be educated in the belief that prevention is better than cure.

(3) Some palatable form of quinine for administration to children would have to be devised.

(4) It must be given so as to be quickly absorbed by the stomach. Otherwise there would be failure.

In carrying out prophylactic measures with a view of preventing the spread of the epidemic, two objects had to be kept in view :—

(1) to protect the individual,

(2) to prevent him from becoming a source of infection to other persons.

It would be admitted that if in a given village one only succeeded in protecting a small proportion of the inhabitants, this would certainly be an advantage to them, but it would have little or no effect in preventing that village from becoming a fulminant area. This was clearly explained in the paper read by Captain Christophers. For these reasons, whilst agreeing that quinine prophylaxis properly carried out, was one of the most valuable weapons in the fight against malaria and whilst admitting that in rural areas it was probably the only weapon at the disposal of Government he felt bound to express his opinion that if they were to place sole reliance on this measure in Indian villages they would be bound to be disappointed. Quinine prophylaxis should go hand in hand with general sanitation and with the destruction of anopheles breeding grounds, whenever this could be accomplished at reasonable expense, and with all possible methods and efforts to improve the physical welfare of the population. He was in favour of no large drainage schemes; he agreed in the views expressed by Major Rogers, and by Captain Christophers, views which are shared also by Major Ross, who in his recent address at Bombay said very clearly that great care must be taken in the selection of large undertakings and that they should only be taken up when the case for them was beyond doubt, and when it was proved that other measures have failed after due trial or were never likely to succeed.

Major James gave a short criticism of the paper which had been read by Major Donovan. He pointed out that it appeared to be of great importance to remove the misunderstanding that evidently exists in the minds of many people to the effect that a salt of quinine which is relatively insoluble in water must be, for this reason, much less effective than a soluble salt. It seemed that the fact was frequently overlooked that the stomach, where much of the quinine is absorbed, contains a more potent juice than water, and that in the small intestine any of the salt that is not dissolved and absorbed in the stomach is acted upon by the bile, which is an exceedingly powerful solvent of the drug. Above all it was a common practice to overlook the work of a large number of Italian, German, and French observers who with remarkable unanimity state that salts of the alkaloid which are exceedingly insoluble in water are absorbed equally as completely as the most soluble salts. He considered that in the light of recent work upon the absorption and elimination of quinine one might even go so far as to say that there are good reasons to believe that when administration is by the mouth the insoluble salts are more efficacious than the soluble ones. This belief rested chiefly upon the observations that an insoluble salt is absorbed somewhat more slowly than a soluble one and that a greater proportion of an insoluble than of a soluble salt is eliminated in the urine. Captain Macgilchrist, I.M.S., working at Edinburgh University, had lately confirmed the latter finding and it appeared obvious that if the useful portion of a dose of quinine is the portion that escapes destruction in the organs and is eliminated in the urine the more insoluble the salt we employ the greater will be its therapeutic value. He noted that Major Donovan's opinion in regard to the uselessness of quinine given intramuscularly was different from that of nearly all medical men in India and throughout the world. The annual reports by Medical Officers of both British and Native Troops in India contained numerous enthusiastic comments upon the great value of this method of administration. The unfortunate results in the case to which Major Donovan referred might have been due to a neglect of the essential rule that in administering quinine by this method care must be taken to dilute the solution very greatly.

Major Donovan replied.

Mr. Narayanamurti said:—As a layman, I have read with interest the paper regarding the use of quinine and though I am not competent to say anything on the scientific aspect of the question, I should like to say a few words based upon about 20 years personal experience and observation in the malarious tracts of Ganjam and Vizagapatam.

I was rather confused and disappointed when I read the first portion of Major James's paper dealing with the problems relating to the use of quinine, but the concluding portion was encouraging. I have great faith in this remedy for malaria and have always endeavoured to induce others with whom I came in contact to use it both as a preventive and cure. I invariably used small doses of 2½ grains pills as a preventive measure in the evenings and gave a pill or two to each of my clerks and chaprassies. I sometimes took a pill every other evening, for some time after returning from the malarious tracts. I am glad to say that by the use of the drug in the manner described I escaped fever altogether and my followers were also to a great extent free from it.

The President moved that the problems mentioned in Major James's paper and those which Colonel Lukis had detailed should be referred to a sub-committee composed of Colonel Lukis, Colonel King, Lieutenant-Colonel Aldridge, Majors Rogers, Donovan, and James, and Captains Christophers and Gage.

The motion was put to the vote and carried.

The following report was afterwards presented to the Conference by this sub-committee.

Recommendations of a sub-committee appointed by the Malaria Conference on the 15th October 1909 to consider in regard to the general civil population of India (1) the doses of quinine that should be employed in order to cure the disease in the quickest time and with the least inconvenience to the patient, (2) the proper times at which the doses should be given, (3) the most appropriate salt of the alkaloid to employ, (4) the most appropriate mode in which to administer it, (5) the best plan of using the drug for prevention.

(1) In our opinion for the cure of adults in the quickest time and with the least inconvenience the amount of quinine to be given daily should be not less than 20 grains nor more than 30 grains of the sulphate, or not less than 15 nor more than 20 grains of the hydrochloride, or proportionate amounts of other salts which contain greater or smaller quantities of the alkaloid.

For children over five years of age half the doses recommended for adults should be given, and for children under five years of age the doses should be for each year of age one grain of the sulphate (or its equivalent in another salt) given the same number of times a day as will be recommended below for adults.

(2) In our opinion it is most convenient to give the 20 or 30 grains (or its equivalent in another salt) in two or three doses of 10 grains each during the day and we consider that the doses should be given whether fever is present or not, but where convenient the 20 or 30 grains may be given in smaller doses at more frequent intervals.

(3) We recommend that after the attack of fever is over the full curative doses should be continued for three days, after which the daily dose should be reduced to five grains, which, with a view to prevent relapses, should be continued for not less than three weeks.

(4) The most appropriate salt of the alkaloid to employ is the hydrochloride or the sulphate. The hydrochloride contains a larger proportion of the alkaloid but is more expensive and being deliquescent is not so suitable for distribution in solid form.

For children either of the above salts may be used, or the tannate, which is, comparatively speaking, tasteless.

(5) Wherever possible the best mode of administering quinine is in acid solution, but we consider that for distribution to the general population quinine must be issued in solid form and we recommend that for children a form as palatable as possible should be adopted.

(6) We consider that the best plan of using the drug for prevention is to take five grains of the sulphate, or its equivalent in another salt, every day (preferably in the evening) during the malarial season.

(7) In the treatment of cases of fever if the fever is not markedly reduced by taking curative doses for a week the patient is probably not suffering from malaria and the administration of quinine should be discontinued.

FIFTH DAY.

Saturday, October 16, 1909.

PRESENT.

The Honourable Sir Herbert Risley, K.C.I.E., C.S.I., I.C.S., *President.*
Sir Harold Stuart, K.C.V.O., C.S.I., I.C.S.
Cav. Filippo De Filippi, F. R. G. S.
The Delegates.

The President asked Colonel Lukis to read the recommendations of the Sub-Committee that sat on the 15th October to report on the subject of quinine.

Colonel Lukis read the recommendations which were accepted by the Conference.

The following paper was then read :—

A Revised Scheme for the distribution of quinine by Government

BY

MAJOR E. WILKINSON, I.M.S.

In Eastern Bengal and Assam considerable attention has been paid in recent years to the distribution of quinine as a means of combating malaria, and since the pice packet system was introduced into Eastern Bengal in 1892 and into Assam in 1894, sales have been very large. In 1908 the number of packets sold was nearly 3½ millions, the sales exceeding, I believe, those in any other part of India. It is probable that one of the chief causes contributing to this result is the liberal profit allowed to retailers. This is as high as 30 per cent, and as upon the unpaid retailing agency the success of any scheme of distribution must primarily depend, it is of first importance that their profits should be substantial. The amount sold for a pice was at first 5 grains. This was increased to 7 grains in 1904 and again this year to 10 grains, when compressed tablets were also made available, three tablets each of 3⅓ grains being sold for one pice. In spite of these large sales available statistics give no reason to believe that in the province of Eastern Bengal and Assam the distribution of quinine has made any appreciable impression upon malarial fevers. This failure I attribute to the fact that quinine is sold in doses and not in treatments, and that those who suffer very rarely subject themselves to continuous treatment. Dr. Bently in a recent paper lays great stress on this point and goes so far as to say that the plan of supplying quinine in pice packets has practically nothing to recommend it except that it is a system which has been in existence for some time. Malaria, he adds, cannot be cured with one dose of quinine, however large, and a sufferer who only spends a pice on quinine is practically throwing away his money. In his opinion the sale of single doses is only likely to mislead people and the policy of merely reducing the price, or rather of increasing the quantity supplied for a pice, is a mistake. He would therefore discontinue the sale of single doses and only issue packets containing from six to twelve unit doses. The Government of Eastern Bengal and Assam, following the recommendations made by Dr. Bently, has recently worked out a revised scheme of quinine distribution, the main feature of which is the distribution not of doses but of treatments, and this scheme I now propose to submit for the consideration of the Conference.

To be effectual, quinine must be supplied in adequate doses and the treatment must be maintained sufficiently long to prevent a recurrence. The cost of the treatment must not be excessive, the directions for use must be simple, and the drug must be issued in as palatable a form as possible, this last condition being especially important in the case of children. In considering what salt of quinine should be used, it will be useful to take the sulphate as a standard, both as to the amount necessary for effective treatment and as to cost, and to compare the other salts of quinine with it.

First as regards the amount required. The treatment of malaria described by Sir P. Manson and considered by him to be effective in 99 cases out of 100, requires as a minimum quantity 115 grains of the sulphate of quinine in solution. This treatment is spread over a week, the first dose being 10 grains, followed by doses of 5 grains every eight hours—that is to say, 25 grains are administered on the first day of treatment and 15 grains daily for the remaining six days.

It is important both for reasons of economy and for the avoidance of the toxic effects of quinine that the smallest effective dose should be prescribed, and Rogers has shown that no advantage is gained by giving more than 20 grains daily of the sulphate in solution. He has also shown that with such a dose the average duration of fever in malignant tertian infection is only 2·4 days and in benign tertian 1·44 days, the maximum duration in malignant infections being six days and in benign four days.

These two observers agree very closely as to the total number of grains required to cut short an attack of fever, and it may therefore be safely assumed that 115 grains of the sulphate administered in solution in doses of not less than 15 grains daily during a week, is an effective treatment for malaria. It is indeed not improbable that a minimum treatment of 100 grains so administered would be almost equally effective.

As regards cost the sulphate is the cheapest salt on the market but although it contains a fairly high percentage of the alkaloid it has the disadvantage of being very insoluble. The accompanying table shows the solubility, alkaloidal content, dose, and price of the salts of quinine in common use :—

Salt of quinine.	Solubility in cold water.	Percentage of quinine contained.	Amount of quinine in a given quantity taking sulphate as 100.	Amount containing an equal quantity of quinine to that in 1 part of sulphate.	Dose in grains taking that of the sulphate at 5 grains.	Price per lb. (7,000 grains), in annas.	Price of effective unit compared with sulphate, in annas.	
							Actual.	Percentage.
1	2	3	4	5	6	7	8	9
Sulphate ...	1 in 800	75·5	100	1·0	5	106	106	100
Bisulphate ...	1 in 11	59·1	80	1·24	6·2	125	155	146·22
Hydrochloride	1 in 40	81·8	110	·9	4·5	172½	155½	146·46
Tannate ...	Slightly soluble.	20·0	27	3·67	18·35	110	403	380·18

It will be seen that, taking the price of an effective unit of the sulphate at 100, the prices of the units of the bi-sulphate, hydrochloride and tannate are about 146, 147 and 380, respectively. If cheapness were the only consideration, the use of the sulphate would be clearly indicated. It is, however, of primary importance that the quinine administered should be absorbed and as, during fever, both digestion and absorption are usually much impaired, it is necessary either that quinine should be administered in solution, or that the salt employed should be easily soluble. Both Manson and Rogers prescribe the sulphate *in solution*. Distribution, however, in this form is not feasible and we are forced, if we wish to obtain the best results, to make use of the bi-sulphate or of the hydrochloride.

It is now necessary to examine which of these two salts possesses the greater advantages. The cost in each case may be taken to be the same but the solubility of the bi-sulphate is considerably greater than that of the hydrochloride. On the other hand, owing to its smaller alkaloidal content, the dose of the bi-sulphate is considerably greater than that of the hydrochloride. In view, moreover, of McCay's observations as to the effect of sulphates in lowering, and of chlorides in raising, the hæmosozic value of the blood serum, it would seem that the hydrochloride is to be preferred, specially in regions in which

black-water fever occurs. For these reasons we propose in Eastern Bengal and Assam to make use of the hydrochloride for the treatment of adults in our revised scheme of quinine distribution.

It remains to determine the amount of the hydrochloride to be issued as a treatment. The actual equivalent of the 100 grains of the sulphate, previously mentioned as a minimum effective treatment, is 90 grains of the hydrochloride, the dose of the latter being 4·5 grains compared with 5 grains of the former. Owing however, not only to the much greater solubility of the hydrochloride but also to its higher alkaloidal content and to its easier digestibility, a four grain dose may reasonably be taken as the unit and it is proposed that the amount issued for a treatment should be 80 grains.

As to the form in which the hydrochloride should be issued, there is no doubt that tablets are preferable to powders. The exceedingly bitter taste of the drug would certainly interfere with its popularity if powders only were available, and this fact has already been recognised in the issue of small tablets of the sulphate in the two Bengals. Sugar coating would, of course, mask effectively the bitter taste of the drug, but it would add appreciably to the cost and is moreover not recommended by the manufacturers on account of the liability of sugar coated tablets to deterioration. Another disadvantage is that such tablets are liable to escape digestion. The treatment, therefore, suggested consists, as I have said, of 80 grains of the hydrochloride made up into 20 uncoated tablets of 4 grains each. These would be administered in seven days, four tablets being given daily for the first three days, and two tablets daily for the remaining four days. Samples of these treatments, put up in glass containers, have been prepared by a firm of manufacturing chemists and are submitted for the inspection of the Conference. The glass tube is corked and the cork covered with paraffin in order that the tablets may be sufficiently protected; a label on the tube sets out the price of the treatment and the tube would be enclosed in a paper containing a simple set of instructions for self-treatment in the vernacular. Ten of these treatments would be packed in a parcel and a parcel would be the minimum quantity sold to a retailer.

It is next necessary to examine the price at which such treatments could be sold by Government to the retailer and by the retailer to the consumer and the loss which Government would be called upon to bear. In making this examination it will be convenient to take a parcel of 10 doses as our unit, and I may mention that it is proposed that the manufacturers or their agents should undertake distribution to Civil Surgeons at a fixed rate of 2½ per cent on invoice charges.

The scale of prices and of profit and loss which has been provisionally worked out by the Government of Eastern Bengal and Assam is as follows—

	Rs.	a.	p.
Actual cost to Government including distribution charges to Civil Surgeons per parcel of 10 treatments ...	2	6	0
Price at which a parcel would be sold to the retailer ...	1	10	0
Price at which a parcel would be sold to the consumer at 3½ annas per treatment	2	3	0
Retailer's profit per parcel	0	9	0
Loss to Government per parcel	0	12	0

The retailer's profit, after taking into account money order commission, works out to about 33 per cent. This may appear high, but it is not, I submit, excessive. Relying as we do on the services of an unpaid agency, it is essential to offer a profit sufficiently high to ensure that sales are pushed automatically, and it seems doubtful whether any scheme of distribution which does not satisfy this condition is likely to succeed. The consumer's price (3½ annas per treatment) is not, for the class of people in Eastern Bengal and Assam which we hope to reach, excessive. Perhaps the most important figure in the table is that representing the loss to Government. This excludes charges incidental to distribution from district depots, but taking the loss at 12 annas per parcel, it would

be possible for an annual expenditure of one lakh to distribute 1,33,333 treatments.

The next important feature of the scheme is the distribution of quinine in a form suitable for children, and no scheme for combating malaria can be considered complete which does not provide for this. It would be out of the question on account of their nauseating taste to make use of most of the salts of quinine, and it is necessary that the drug should be given in a form which will not only not be objectionable, but which may be sufficiently attractive to induce children to ask for it. This would be possible if a comparatively tasteless salt of quinine were mixed with some sweetmeat as has been done in Italy where, I believe, chocolate confections of tannate of quinine have proved highly popular. It is, however doubtful, having regard not only to the deterioration due to the climate, but also to possible religious objections, whether this example could be followed in this country.

In spite of its many disadvantages, its insolubility, its low and variable alkaloidal content (with its consequent higher dose) and its indigestibility, the tannate appears to be the only tasteless salt of quinine which could be made use of in any widespread scheme or distribution. Euquinine and aristochinine would probably be equally effective, but their cost is prohibitive. For an adult an effective dose of tannate is about 18 grains, compared with the 5 grain dose of the sulphate. For a child of from 7 to 12 years of age the dose would therefore be about 9 grains and the average dose for young children may be taken at 5 grains. As children find it difficult to swallow tablets it would be necessary to issue the tannate in powder form, and if the powder be mixed with sugar children would find it attractive.

The treatment for a child, it is suggested, should consist of 20 powders, each of five grains, of the tannate. These, separately packed, would be enclosed in a waterproof envelope and ten of these treatments packed in lead foil would constitute a parcel. I now give a scale of prices and of profit and loss similar to that already given for the treatments for adults. The figures are worked out on the basis of a wholesale quotation of 7 annas per ounce :—

	Rs.	a.	p.
Actual cost to Government per parcel of ten treatments including distribution charges to Civil Surgeons	1	1	0
Price at which a parcel would be sold to the retailer ...	0	7	0
Price at which a parcel would be sold to the consumer at one anna per treatment	0	10	0
Retailer's profit per parcel	0	3	0
Loss to Government per parcel	0	10	0

We propose to give to the retailer a somewhat higher rate of profit than that obtained from the sale of treatments for adults. Our object in doing this is that this important part of the scheme may have every chance of success from the outset. At the same time the margin of profit should not be too great, as otherwise the danger would exist of retailers pushing the sale of tannate at the expense of hydrochloride treatments, and as the former only contain about one-quarter of the quinine necessary for the treatment of an adult, this result would not only cause unnecessary loss to Government but would prejudice the success of the whole scheme.

The next point to which I would refer is the stimulation of sales by extensive advertising, and the scheme which is being worked out for Eastern Bengal and Assam includes the somewhat novel proposal that there should be attached to the office of the Sanitary Commissioner a Publication Department which would by continuously and extensively advertising in the vernacular newspapers and by picture posters bring home to the people the advantages of continuous treatment. If we are to oust quack medicines and fever mixtures we must fight them on their own ground and appeal to the masses in the manner best calculated to impress them.

Side by side with the sale of quinine under the system I have outlined, it is proposed to undertake in malarious localities—and especially in localities where the people are too poor to afford the cost of a treatment—the free distribution of quinine by specially appointed hospital assistants or other reliable agents.

These, then, are the four main features of the scheme which I submit for the consideration of the Conference. The sale of single doses would be discontinued entirely, and in its place would be substituted the sale of treatments—treatments of hydrochloride being issued for adults and of tannate for children. Government would push its sales by advertisements and in specially selected localities free distribution would be undertaken.

I have not dealt with the important subject of the retailing agency, as this, I understand, will be separately discussed by the Conference. Although in Eastern Bengal and Assam we find that postmasters are our most successful salesmen, we cast as wide a net as possible and employ school masters, members of village *panchayats*, *chaukidars* and shopkeepers.

The following paper was then read :—

Experimental Demonstration Camps

BY

MAJOR S. P. JAMES, I. M. S.

It is now universally recognised that the problem of the mitigation of malaria in India is chiefly the problem of its mitigation in small villages, and it is therefore exceedingly satisfactory that the correct method of attacking the disease in those areas is no longer a subject of controversy. Differences of opinion in regard to the steps that should be taken in cities, towns, and even cantonments, are still justifiable, but all who have made a special study of malaria have arrived at the conclusion that the mitigation of the disease among the population of villages is to be accomplished by quinine alone. This decision has not been arrived at hastily or without due trial of other methods, but if these trials and probings after truth have caused delay they have enabled the verdict to be founded upon a firm basis of observation and experience. And indeed now we are aware that an advocate of anti-mosquito measures so ardent as Major Ross, has admitted that quinine measures are the correct ones to adopt in Indian villages, we may rest assured that the last word on the subject has been said and may betake ourselves immediately to devising schemes for popularizing the use of the drug in those areas. Such a task commends itself not only on account of the good results to be expected from a more extensive use of the drug, but because it is in continuation of the policy of bringing quinine within reach of the poorest inhabitants which was commenced by the Government of India more than half a century ago. It is well known that the means then adopted with the object of cheapening the drug revolutionized the quinine industry of the world, and that, by the introduction about 35 years later of the system of selling pice packets of quinine at post offices, India became the first country to attempt a serious combat against malaria among native races. That as regards the great bulk of the inhabitants of this country the attack upon the disease must be attempted according to a plan of that kind, the people who are affected bearing, by the purchase of the drug at a cheap rate, a great part of the expense, will be apparent to anyone who considers the enormous cost of any scheme which postulates a free distribution of quinine. Our primary object therefore is to devise a scheme for increasing enormously the demand for pice packets of the drug, and I propose in this note to treat very briefly of a plan that I think merits trial with this object. The plan that I recommend is the establishment in selected areas of every province of what may be called experimental demonstration camps—experimental because they would form a means of testing the value of quinine for the mitigation and prevention of malaria among the general population, and demonstration because their primary object would be to demonstrate to the people the benefits of the drug and the correct way in which to use

it. It is certain that at present, even if the villagers of India generally are aware of the existence of a drug like quinine, not a fractional proportion of them know where this medicine is to be obtained, or how to use it, or what great benefits its use would confer upon them, and it seems to me that in the first place it is our duty to teach the people these things.

The following are some headings that may serve to indicate the principles on which the camps should be initiated :—

1. If possible a camp should be established in each district of a province. It should be situated in the most malarious part of the district and its operations should be confined to a population not exceeding 2,000 people.

2. The staff for each camp should consist of one selected Hospital Assistant and one Compounder.

3. One medical officer should be appointed for the supervision of all the camps in a province; he will tour from camp to camp, staying a few days at each.

4. On arrival at the selected area the staff of the camp will establish themselves in a house or tent in the centre village of the area, and their first duty will be to make it known to the people that they have been appointed by Government to treat anyone who may be suffering from fever. For two or three weeks they will confine themselves entirely to the task of endeavouring to cure as quickly as possible those who voluntarily seek their aid. By this means the purpose of their visit will become known and the confidence of the people will be gained.

5. Afterwards they will work on a more systematic plan and in the first place will secure by a house-to-house visitation : (1) a census of the people by ages and sex ; (2) a list by names, ages and sex of everyone who is suffering from fever or enlargement of the spleen.

6. The task of curing all these people will now be begun in earnest. The work should be shared by the two officers, but I think that as a rule the Compounder should remain at the camp in order to treat all who can attend there and the Hospital Assistant should spend the day in visiting and treating all who cannot or will not leave their houses.

7. *The essential feature of the campaign will be the treatment of all patients with the quinine put up in the pice packets that are sold at post offices.* Whenever anyone requires a dose of quinine the Hospital Assistant or Compounder will show him the pice packet, will open it in his presence, and while the dose is being taken will explain to him the way in which it is to be used for both treatment and prevention and where and at what price it can be obtained when the camp has ceased to exist. This little lecture should be prepared beforehand and should not vary in any detail ; by its constant repetition the people will learn how to use the drug for themselves and by the time the camp has ceased to exist it will be possible to say that, at any rate among the 2,000 persons in the area of operations, there is no one who does not know where to obtain quinine and how to employ it. The Hospital Assistant will also demonstrate to the people cases of enlargement of the spleen and from time to time will show them how remarkably the organ decreases in size as a result of the treatment. From my experience in Mian Mir I know that this is an easy and sure method of getting the people to understand the benefits to be derived from quinine.

8. This brings us to the important subject of the dosage that is to be adopted for treatment and prevention. In the first place it is essential that in a camp of this nature all patients must be treated in exactly the same way so that no confusion on the matter will exist in the minds of the people. It is not possible here to discuss the various methods of treatment that might be adopted and I will only say that in the present state of knowledge, and having regard to all the circumstances of the problem, it seems to me essential that for the treatment of patients we should adopt the principle of giving small doses of the drug at frequent intervals. With this object I recommend that *each packet should contain four grains of quinine and that five of these packets will be the amount of medicine required for 24 hours*, the doses being given at sunrise, morning, midday, afternoon and sunset. When the Hospital Assistant sees a patient he will administer one dose to him, will deliver the little lecture already mentioned,

and will then hand over to him a sufficient number of packets to last until the next day, or the next day but one, according as the pressure of work enables patients to be seen every day or every other day.

9. It is for consideration whether packets of tannate of quinine should be used for the treatment of children. If this were done the doses should be enclosed in an envelope of a colour different from that of the packets used for adults. The introduction of an arrangement of this kind would simplify the instructions greatly.

10. The Hospital Assistant will not confine himself to the treatment of cases, but will do his best to push the use of the drug for prophylactic purposes. To take one packet of four grains of quinine every night is the best way to employ the drug for this object and I see no reason why, with tact and perseverance, a number of the healthy inhabitants of the area should not be induced to adopt the measure in order to convince themselves and their neighbours of the efficacy of the drug for this purpose.

11. A feature of the campaign will be the constant endeavour to interest the inhabitants in the scheme by frequent demonstration of its benefits, and to this end I think it should be the duty of the inspecting medical officer to address the people at each of his visits. I cannot enter into detail regarding these addresses here, but it will be obvious that at the first address he should explain the present state of the area, should give some idea of the number of people who are suffering from fever or enlargement of the spleen, should describe the measures that it is proposed to employ to show the people how they can help themselves to stamp out the evil, and should explain to them that, though the treatment will be entirely free while the camp is in their area, they will have to purchase the drug when the camp has ceased to exist : and that at the last address before the closure of the camp he will review the results that have been achieved, will explain how they have been brought about, and will make it plain that if the people continue to use the drug in the way that has been demonstrated to them they need have no fear of malaria. He will explain to them yet once again that a large supply of the drug has been left either at the post office or at the principal shop, as the case may be, and that its price is two doses for one pice. In front of this post office or shop should be erected an advertisement board stating that " Government quinine is sold here."

12. I consider that from six weeks to two months should be the length of stay of each camp in the selected area and that at the end of this time the camp should be moved to the group of villages adjacent to the area already dealt with. By this arrangement the influence of the camp will not be suddenly and entirely lost. Assuming that a camp remains two months in each area of 2,000 people, 12,000 people would be educated per annum and assuming that a province contains 30 districts, each with its own camp, the number of people educated yearly would amount to 360,000. If a camp were started in each district of British India about three million people per annum would learn thoroughly the benefits to be derived from quinine, where to obtain it, and how to use it.

13. In considering the cost of this scheme it has to be remembered that the outlay is not a recurring one for each area dealt with ; once the people of an area have received their two months teaching the only expense is the small loss that might result from the sale of quinine at less than cost price. It has to be remembered also that the charge is really for the purpose of teaching the people how they can save themselves from misery and death, and that from any point of view it is more important to instruct them upon such a subject than it is to instruct them in the arts of reading and writing. If we assume that the consumption of quinine in each camp would be 1,000 doses a day, it would be allowing a considerable margin for incidental expenses to assume that, including the salaries of the staff and the supervising medical officer, Rs. 350 per month would be the cost of each camp. Considering the benefits that might accrue this is not a great sum.

14. It seems to me that the scheme I have roughly sketched out is one which should appeal not only to Governments but to private philanthropy. At the present time when there exists in this country so strong a feeling that to

mitigate malaria something must be done, it is at least of importance for the charitable to know that Rs. 1,000 expended in the way I have described, might be the means not only of saving a considerable number of lives but of alleviating directly and indirectly an incalculable amount of suffering and misery.

15. Finally I put forward the scheme as an attempt to solve the problem of free distribution of quinine. I think the futility of distributing quinine to village headmen for indiscriminate use among the people must be patent to all, and that it would be a good principle to distribute no quinine free in this country except through an agency somewhat similar to that which I have described. If this principle were adopted the authorities would obtain an adequate return for the expenditure incurred, the return being the knowledge that the distribution was being beneficial and that by its means the people were being thoroughly educated in the manner of saving themselves from death. In the attempt to mitigate malaria in India, Governments and other authorities have an obvious duty to perform, but the duty is not limitless, and personally I think a considerable part of it will have been done when, after teaching the people how to use quinine in a proper manner, the drug has been everywhere made available to them at the cheapest possible rate.

The following discussion ensued :—

The President said : It happened in 1892 that I started in Bengal a system of selling quinine in pice packets at Post Offices. I had the greatest opposition to meet; people said absurd things, one of which was that Post Masters would take the trouble of opening several thousand packets—not easy packets to open by the way—and that they would extract the quinine, would sell it and would substitute something else. I do not believe this has ever happened. The principle, as Major Wilkinson has explained, was that for the smallest coin in use quinine should be available at places which people frequent. The results were shortly revealed. I think three years after the system was started by Government it was found that the demand in each district appeared to bear a definite relation to the amount of malaria; that is to say, that, in the most malarious districts, the demand per thousand of the population, or whatever the system of calculation was, corresponded with the malarious character of the districts. Jessore ranked very high, also Rajshahi, exactly the places at which you would expect that the drug would be most necessary. The people were advised by printed instructions on the packets how to use this treatment. The plan has now been in force for a great many years and has worked well; the Post Office is a place which a great many people frequent and in many villages it really is a sort of club; the people go in and talk about their affairs; it is a very popular place. Are we now going to displace this system, or is it possible that the system can be modified in some respects so as to fit in with more modern ideas as to the proper mode of using and distributing quinine?

Mr. Ferard said that there was a Conference last year in the United Provinces about the best method of distributing quinine; the subject of travelling dispensaries was considered and it was not accepted as it was found to be very expensive. In ordinary times in the United Provinces pice packets are sold; they are distributed by village accountants, vaccinators, sub-treasury officers of Tahsils, sometimes the agents of zamindars, subordinate officials of the Canal Department, school masters, and in fact the most trustworthy officials of various Government departments. In addition, officers on tour and supervisors of accountants are given pice packets to sell. A commission of 1 per cent is allowed. He might safely say that in the United Provinces there is not a village of which the adult members do not know where they can get quinine. Every village has an accountant and a Post Office. The amount of quinine taken was considerable and was increasing. All this was done in ordinary times. The question arose as to what was to be done in periods of epidemic. The Lieutenant-Governor has decided that a supply of quinine should be given to officers on tour, that is the Assistant Collector, Assistant Tahsildars and Supervisors of village

accountants who should each have a circle of about 100 villages; their tours coincided with the beginning of the malaria season. The distribution was free. In addition the most important method of distribution was the non-official agency which consisted of village headmen. In the fever epidemic of 1908 in some parts of the Province a considerable amount of quinine was distributed in this manner, by zemindars personally and by their agents. The consumption of quinine does not vary with the degree of malaria in a district; it depends on the education of the people. As a matter of fact the amount was increasing. Experiments were being tried of giving quinine gratis to school children in certain districts. In ordinary non-epidemic times every possible agency of Government was utilised to sell these packets. In epidemic times non-official agency was also very largely employed. He did not think demonstration camps were really required in the United Provinces, though they might be elsewhere.

Mr. King described a scheme which had been adopted in the Gurdaspur district of the Punjab in 1908. A quinine distribution association was formed which was taken up keenly by the educated classes, who worked hard to make it a success. The organisation was somewhat similar to that of the Blue Ribbon Army the rules being that each member bound himself to take quinine once a week and to induce as many other people as possible to become members of the association. Each member had to pay a subscription of six annas a month to cover the cost of the quinine but in addition there were non-paying members from among the poorer classes. As a rule, however, it was considered a point of honour to be a paying member. The lambardars enrolled members and collected the subscriptions which were transmitted to the central office at Gurdaspur. Some of the larger land-holders and zamindars had actually proposed that it should be a condition of tenancy for all tenants to become members of the association. Commissioner Booth Tucker of the Salvation Army had taken up the scheme keenly and his efforts had led to a large increase in membership and to the enrolment of people who could not be reached by other agencies. The total cost of the quinine distributed to members of the association since June 1908 was over Rs. 15,000 and at the end of the year the books showed a profit of seven rupees. He considered that as an experiment the scheme had been entirely successful.

Mr. Sunder Lal said that the United Provinces was divided up into circles, and in an epidemic each circle was placed in charge of a member of the district Board. A list of the headmen of villages who were prepared to distribute quinine was then made. Superintendents of the different circles were collected, and instructions given to them by the medical authorities, also printed instructions. This scheme was put in hand long before an outbreak, and on an epidemic occurring work could be started at once. The quinine was to be distributed in 5 grain pills.

Mr. Lawrence said: In regard to the sale of quinine there are three points I wish to bring to the notice of the Conference. You are no doubt aware that our proceedings here are viewed with the gravest suspicion by certain sections of the Indian public. It has been suggested that this Conference is a gigantic fraud convened to cover a financial swindle. It is pointed out that whereas the market price of quinine is Rs. 8 per lb., Government are selling it at Rs. 14. Now where does the balance go to? One theory is that since the Indian Government is known to be bankrupt, our President has conceived this device for replenishing the exchequer. A more popular theory is that a Simla Ring has cornered the world's supplies of quinine and proposes to make millions out of the dire necessity of the *ryot*. I am sorry to see that this latter theory will receive support from an innocent expression used in a recent letter by Major Ross to the *Times*. Major Ross has predicted that this Conference will go solid for quinine, firstly because the medical mind is incapable of appreciating the value of anything except medicine, and secondly "for other reasons." Now to the Native editor pondering the problems of the Empire, there is a world of meaning behind these few words of dark mystery. It is clear to him that Major Ross is on the track of a secret conspiracy. To disarm these apprehensions I submit that arrangements should be made to sell Government quinine to Local Bodies at the current market price.

Sir H. Stuart:—The price of quinine is fixed for the year at the average price of Howard's quinine for the previous year.

Colonel Lukis:—The price of quinine is not now as high as Rs. 14.

The President:—Where does Mr. Lawrence obtain this figure from?

Mr. Lawrence:—It is given in the native press; and you will find it also in the report presented to the Conference yesterday under the orders of the Inspector General of Hospitals, Punjab. Within the last month I have myself bought quinine pills for the Local Board of Sukkur from the Government Medical Stores at Bombay at about this price.

Colonel Lukis.—The price of pills is higher than the price of quinine, but a mistake has been made in the price quoted.

Mr. Lawrence.—My second point is that an estimate should be made of the available supplies of quinine, and arrangements made for the effective organisation of the distributing agency. Last year when the Punjab Government distributed some 6,000 lbs. it is well known that difficulties were experienced in meeting this demand. Last October when I required the small amount of three pounds from the local depôt at the Hyderabad jail in Sind, it took nearly a month to supply me. There is a danger that when we have set up an elaborate machinery for distribution, work may be brought to a standstill for want of quinine.

The President.—There was plenty of quinine at the factory.

Mr. Lawrence.—There may have been. My third point is that the method of organisation of the retail distribution of quinine should be left entirely to the local Government. In the paper with which the Sanitary Commissioner opened these proceedings a special Malarial Committee was proposed, and it was suggested that this Committee should control the distribution. This form of centralisation would certainly not be effective.

Colonel Leslie.—The Committee is stated to be under the local Government.

Mr. Lawrence.—The proposal is that the Committee should report to the Sanitary Commissioner with the Government of India.

Colonel Leslie.—The object of the proposal is misunderstood.

Mr. Lawrence.—I am glad to receive this assurance. As it stood, the proposal appeared to be a grave departure from the recommendations of the Decentralisation Commission of pious memory.

Major Rogers.—In the Government of India Resolution of 1903 the figures showed that the distribution of pice packets from 1892 to 1900 in Bengal was ten times as much as in any other province. I desire to refer to two experiments, one in regard to the use of quinine as a prophylactic, the other in regard to its use as a cure, which have been recently made in this province. The experiment in the use of quinine as a prophylactic was made in a small rural municipality of about 3,500 inhabitants; the population had decreased in the course of 18 years from 4,600 to 3,500; they were practically dying out of malaria. In this place an Assistant Surgeon was put on duty before and throughout the malarial season; he went from house to house and saw the people take the quinine tabloids himself. But in July he distributed only 600 tabloids in 200 houses, in the next month 450 tabloids in 40 houses, and in the next the people in only 30 houses would take it. It was clear that the people would not take the drug for prophylactic purposes. This distribution was an absolute failure.

The other experiment was made in some of the most unhealthy *thanas*. A system was established of itinerant Hospital Assistants with a small dispensary. There were 17 Hospital Assistants in the first year and 19 last year. The experiment was limited to small areas, one or two Hospital Assistants to each *thana*, so that they could go round to the villages at frequent intervals. This plan has been highly popular and the people have asked for it to be extended. It has certainly educated the people as to the value of quinine. The Hospital Assistants have succeeded in getting the people to take the quinine as a curative

but not as a prophylactic. Mr. Ferard's remark that in the United Provinces there is not a village without a post office and not a village in which the adults do not know where to get quinine cannot be applied to Bengal. My enquiries in Dinajpore showed that in a tract of 150 miles there were only 43 post offices. In large areas the people were cut away from the Post Offices which distributed the quinine, and I said that it was necessary to have a much wider distribution. I suggested village school masters because I found that three-fourths of the deaths occurred amongst childern. An arrangement was then made for the formation of centres all over the province and it was settled that no village should be more than 5 miles from a centre. The results however had not proved successful in extending the sale of quinine. I suggested the payment of a fair profit, but my suggestion was not accepted and the system had failed for that reason. Mr. Oldham had lately reviewed the position in Bengal and concluded his remarks by saying. "What strikes one most is the spasmodic and disconnected character of the measures taken and the want of system by which sustained and continuous efforts towards popularising the scheme would be assumed." Under the present system the pice packet contains 10 grains in Bengal. This means a loss to Government. Sir E. Baker has faced that and given a grant to cover it. We have adopted a system somewhat similar to that recommended by Major Wilkinson, 8 doses being sold in one packet for 2 annas, and in each packet there is a printed form describing how the quinine should be taken. As regards Major Wilkinson's suggestion, I think the pice packet and the treatment system should be allowed to run side by side. I think it would be a fatal mistake to do away with the pice packet system in Bengal at present, as the pice packet is well established and popular there.

Mr. Nathan desired to say a few words in support of the change of system recommended in the paper read by Major Wilkinson. The President had said that the problem for consideration was whether the pice packet system was to be abandoned or remodelled in any way. In his opinion the pice packet system had been a great failure both from the point of view of sales and of effect and in Eastern Bengal and Assam it was now desired to remodel it, as had been explained by Major Wilkinson, and to introduce a system which he thought would become more popular. He thought there was no doubt of the failure from both points of view; in Eastern Bengal and Assam more quinine was sold than in any other Province and still the local Government were so impressed with the uselessness of the present system that they desired to modify it. Looked at numerically, he took the instance of the United Provinces, and in spite of the admirable organization and the numerous agencies which had been described by Mr. Ferard the actual sale in 1907 as compared with the population, was infinitesimal, 722,000 doses, a negligible quantity. To show how small the figure was he instanced the case of Backergunge in Eastern Bengal and Assam where in 1908 in a single district 2 million doses were sold, nearly three times that of the sale in the whole of the United Provinces during 1907. Other provinces showed similar poor results. It was said that they were destroying a great agency that at present existed, but considering its want of success, he did not think it was a great agency.

Next as regards the question of utility, he again instanced Backergunge where an experiment had been made on a larger scale than anywhere else; two million doses were sold in 1908, which was twice the amount in the whole of Burma. Then as to results, Captain Scott, Civil Surgeon of Backergunge, informed him that no one in the district took quinine in sufficient quantities to do the slightest good; the whole of the expenditure incurred on this system there was held to be a waste. That being so, it was surely time to modify the system. Captain Scott was not alone in his opinion. Dr. Bentley held the same view and his experience was very great. All the authorities in Eastern Bengal and Assam who had dealt with the matter held this view. Major Rogers had made the suggestion that the two systems might go side by side. If the two quantities were sold side by side, the one costing a pice and the other three annas, the probability is that the cheaper one would be bought to the exclusion of the dearer. Then as regards

the manner of distribution, in Eastern Bengal and Assam the Post Offices are largely used, and other agencies similar to those mentioned by the Commissioner of Allahabad, should be encouraged—above all, masters of primary schools. If they could get children to take the quinine a great deal would have been done to modify the effects of malaria. In addition to the official agencies, he hoped as time went on, they would employ private vendors more largely. The profit at present amounted to 6 annas on 102 packets. The Civil Surgeon of Backergunge said that in that district about half the sales were through the Post Office and half through private vendors; that was to say that by the system of private vendors there was a larger amount sold than by the whole of the organization employed in the United Provinces. This was a point that needed special attention. The private vendors got their supply from the Civil Surgeon. The Jail supplied the Civil Surgeon.

Mr. Chaudhri said: While strongly endorsing all well-planned methods to popularise quinine the education of the people on the subject should not be lost sight of. In my humble opinion, it is one of the chief ways—if not the most important—of bringing home to the people at large the benefits of such a well-known prophylactic against malaria as quinine is. Whatever measures might be adopted about the form, preparation, sale or free distribution of quinine, the best and never failing method will be to educate the people. It is admitted that there are quacks who, in praising their own specifics for fevers, speak adversely of quinine, while there are people who have strong prejudices against quinine. I know from experience in my part of the country, the cultivators and ordinary labourers when advised to take this drug, say that quinine and such like medicines are never meant for them and they go in preference to *ojhas* or village quacks. Hence it is absolutely necessary to educate the young and the old on this subject by means of lessons introduced in the school books and by leaflets, health series, and popular lectures. The school going population of the primary standard who are to be the future citizens of the Empire and who are likely to influence their parents and relatives as to the uses of quinine should have booklets introduced containing lessons in all the vernaculars on the uses of quinine, including suitable lessons on village sanitation and simple rules of hygiene. I understand from the Sanitary Report of 1908, the Eastern Bengal and Assam Government has undertaken to introduce lessons on quinine. The preparation and publication of *health series* in the vernaculars written in easy style comprising lessons not only on quinine but on sanitation and hygiene should be the next step aimed at. The *health series* should in its initial stage be offered at a reduced rate and in some places free distribution should be indulged in. To reach the masses in the remote villages leaflets written in clear and easy language should be printed in all the vernaculars which should be meant not only to accompany the sale of the best quinine treatment adopted but should be distributed broad-cast in large numbers by intelligent distributing agencies. In all these methods, the co-operation of the people is necessary. The services of the leaders among the people in the various centres of the provinces should be secured to co-operate with the special staff or committee under the supervision of the Sanitary Commissioner to deliver lectures in localities affected with malaria and where literature on quinine treatment may be exhibited for sale and thus gradually extend the operation to places less affected. Popular lectures by Hindu and Mahomedan leaders under the auspices of the Sanitary Commissioner will go a great way to strengthen the operations to introduce and popularise the use of quinine.

Cav. Filippo De Filippi in reply to a request by the President that he would describe the system of distribution in Italy said that he had not made a study of the subject, but he believed that the Red Cross Society under the Geneva Convention go out to the Campagna and pitch a camp in a malarial district, and stay there the whole of the season, the next year they go to another district and so on; the Society was not numerous enough to conduct operations on a very large scale.

Major Wilkinson said that he had spoken to an Italian doctor from Calabria who said that the prophylactic operations conducted by the Italian

Government had been exceedingly disappointing. They could not get people to take quinine in the belief that they would thereby protect themselves.

Mr. Ferard said with reference to the remarks of Mr. Nathan that the full organization sketched for the United Provinces was only decided on the 2nd of June 1909. The heads of the organization were post masters, vaccinators, village accountants, supervisors or *kanungos*, stamp vendors, sub-treasury agents, landlords, agents and canal officials.

Mr. Cholmeley said that Burma had got a reputation for fever which was undeserved. The Province was divided into the wet and dry zones. The fever death rate in lower Burma was 10 per mille and in Upper Burma it was very seldom above 8. He understood the death rate for India was 19, so that the reputation Burma had got was unfounded. Since the annexation conditions had improved; this was due to the gradual clearing of the jungle since 1885 and to the construction of drains, &c. He mentioned some districts which were formerly malarious and in which conditions were now different. The sale of quinine was very small, in 1908 the total amount was 478 lbs. That did not go far in a population of 10 million; the larger part was sold in Lower Burma. He read the rules as regards sales. The distribution was through vaccinators and headmen of certain selected villages, *tehsildars* when on tour, and post masters. The only change that had been suggested was that powders would be replaced by pills of 7½ grains. He read a Resolution on the subject of the vendor's profits. No doubt the sale should be extended; the headmen should be induced to push the sale by giving them a larger profit than at present. The sale might also go on in drug shops.

In reply to a question by the President as to whether the priests might be induced to take it up, seeing what they had done for education, he was doubtful if it could be done.

Captain Baket explained that such a system would not be feasible as priests were not allowed to handle money.

Mr. Cholmeley went on to say that they had no malaria epidemics in Burma. Since such distribution as had been made, he had noticed no difference in the death rate. He agreed with the President that malaria was not so bad in Burma as to need any particular measures.

Mr. Maude asked if it was an established fact that 10 doses were necessary for the cure of malaria. He had cured his servants and others on many occasions with less than 10 doses. If the necessity of 10 doses in all cases was not established then Major Wilkinson's proposal to issue only treatment quantities seemed to fall to the ground. It would be a great mistake to give up the issue of pice packets the sale of which had been steadily increasing and substitute for it another method. One could not escape the conclusion that if the pice packet method were abandoned, there would be an enormous fall in the sale of quinine throughout Bengal. Since the Government resolution which Major Rogers quoted had issued, there had been a steady increase in the sale of pice packets and there was strong evidence that the increase was due to the purchase not by ordinary people, but by quacks, *vaids* and *hakims*.

Colonel King said that he agreed with Mr. Cholmeley in his statement that there was no fever in epidemic form in Burma as in the Punjab. Such malaria as they had was localised and therefore did not swell the general statistics of the province. It had declined in respect of disciplined bodies such as troops, military police and prisoners, as the result of judicious use of quinine prophylactically, combined with local improvements of drainage, and the use of mosquito nets among about 13,000 or 15,000 people. Particulars on this subject would be found at pages 5 to 7 of his report. From Major James's paper it would appear that he would lead us to believe that Major Ross would apply the use of quinine to villages indiscriminately, that is to say, if a place be malarious, and it be a village, practically no other measure would be adopted. He did not think that was Major Ross's intention. This matter was of very great importance and he would like to quote Major Ross's own words as given in his recent letter to the *Times*. They were as follows: "I do not decry quinine prophylaxis; there is no real rivalry between it and mosquito reduction, and each ought to be used in its proper place—as I have described at length in various publications. Our great object is to combat the disease by every means in our power; but it will

be a disaster for India if those who advocate a sole and universal quinine prophylaxis succeed in suppressing other and sometimes more appropriate measures. We can only hope, therefore, that full opportunities will be found at the conference for the expression of wider views. There appears not to be a single engineer among the members originally nominated. Medical men are apt to be biassed toward quinine prophylaxis because they naturally understand medicines better than drainage and public works—and for other reasons." He suggested that the correct interpretation of the words "for other reasons" was not that implied in the sinister bazar rumours which Mr. Lawrence had mentioned but had reference to the well known fact that provincial Governments had difficulties of a financial nature in meeting sanitary requirements.

Colonel Lukis said that in regard to the measures which were appropriate for villages it was difficult to gather Major Ross's opinion from the extract quoted, and that in circumstances like the present it was unwise to rely upon correspondence in lay newspapers. He therefore thought it right to quote, from a reprint of Major Ross's speech at the Bombay Medical Congress, the following extract which appeared to express clearly Major Ross's view as to the correct measures to adopt in Indian villages. "For scattered populations, small villages, and rural areas we must generally fall back upon quinine, because the cost of drainage is likely to prove too much in comparison with the benefits likely to accrue from it."

Major Rogers said that experiments upon the use of quinine as a prophylactic had been made among the police in selected areas in Bengal. They had been made in the most malarious places and gave evidence of the great value of the drug for the purpose.

Colonel Dyson said that in Bombay the system of the distribution and sale of quinine was as yet in its infancy and there were no figures to offer. There were differences in the Presidency as regards the malarial areas. In Sind people were beginning to recognise the value of quinine and there perhaps such an agency as Major James had suggested would be of value, but there were other places, for instance the jungle tracts of the Panch Mahals and North Canara, which were absolutely new ground. In the latter place pice packets had been placed at the disposal of the people and had been found just as they were handed over to the village authorities, unopened and mouldy. In such parts it was considered almost hopeless to overcome the apathy of the people, and what was wanted was some stronger agency for the distribution of quinine. The suggestion was that travelling dispensaries should be used; they were tried and were closed this year as they were considered to have failed. He thought there were sufficient reasons to explain this failure. In the first place, no trouble was taken in the selection of the hospital assistants in charge of the dispensaries; certain centres were allotted and were too large; the experiment was continued for the period of two years, and it was considered that the cost of the experiment was too great. He thought, if travelling dispensaries were properly organized and the hospital assistant properly selected and sent round in the worst time of the year, if moreover, some special concessions in the way of pay, promotion, or allowances were given them, and the area restricted, the experiment might succeed. He would suggest that the area should be such that the hospital assistant would be able to visit each village at least once in a week or ten days, so that he could reappear at each spot about four times in a month. It had to be remembered that in these tracts even Western medicines were unknown, leave alone quinine. It was exceedingly necessary to have continuity in such matters; if the travelling dispensary system was to be tried again, the men selected should remain there for a period of years so as to get used to the people and to teach them the use of quinine. The men should be selected carefully. It had also to be remembered that as regards the distribution, there would be difficulties as there was no such thing as a village site; the villages consisted of isolated and scattered groups of huts; there were no schools, no post offices and no shops, so that teaching in regard to the use of quinine would have to be very thoroughly undertaken. Further, the distribution would be through the headmen and the sale would be at a market town. He again emphasized the necessity of continuity if any benefit was to be derived from the measure. The Bombay Government had decided to continue a further trial of travelling dispensaries.

Mr. Weir said that in Madras the distribution of quinine was left to the agency of the post office. The sale was not large. In Madras there was no malaria in epidemic form, and so it was not necessary to take the same measures as in some provinces. The worst cases of malaria were generally in hills and forests inhabited by wild jungle tribes and no quinine could get there, no matter what agency was employed. In some places perhaps some of the agencies mentioned could be employed, for instance, school masters, vaccinators, etc. In affected areas the Government had deputed hospital assistants to distribute quinine.

Mr. Fox-Strangways said that figures for the Central Provinces were very small. They issued quinine through the post office, school masters, stamp vendors, and in five districts through *patwaris*. The total amount in 1905 was 365,000 7-grain pills. In 1908 the figure was rather less than one-third of that given. There were some reasons for this decrease; one was that the commission given was 1½ annas as against 6 annas in some places; another reason was that the people were offered something different to what they were given in a hospital, and this puzzled them. There should be no difference. The methods for improvement which they should employ would be to increase the amount of commission, extend the *patwari* system, and enlist to their aid other agencies. They did not nearly enough employ the Police, Forest, and Revenue officers and other Government servants. He considered that the most promising way of pushing the knowledge of quinine was not by taking areas specially liable to the disease, but by trying to induce the whole population to believe in it and to spread it by means of Government officials.

Mr. Mudholkar would not discontinue the system of pice packets. There were many people who would find it impossible to spend large sums but who could afford to buy the pice packets.

Mr. Goswami was of opinion that the two methods should proceed side by side; they had been found successful in Bengal.

Mr. Choudhri said that if the expensive and cheap methods were displayed side by side, people would only buy the cheap one.

Mr. Wadhia said that in Bombay they had been distributing quinine gratis, but very often people made no use of it. It was frequently found stored up as received; in some cases it had actually been sold in the bazaar for what it would fetch.

Captain Gage in reply to a question by the President said that in Bengal if they took up the present new extensions, they could grow enough bark to produce 50,000 lbs. of quinine per annum. On the eastern side of the Teesta there were 5,000 acres of culturable land, but they were not likely to get enough land in Bengal to get the outturn to reach 100,000 lbs.

Mr. Weir said that he believed in the Nilgiris there was a large area suitable for the growth of cinchona, and if the demand made it worth while planters would grow cinchona.

Sir Harold Stuart said that taking 250 grains as the amount of quinine required for each person as a prophylactic during a malarial season of 90 days 100,000 lbs. would be required for 3 million people for prophylactic purposes. The amount required for cure was about the same. Major Wilkinson had proposed only 80 grains while the Sub-Committee proposed 240, but Major Wilkinson had not provided for the after treatment.

Captain Gage said that the production in Madras was mostly from imported bark, but in Bengal they would in two or three years be able to harvest sufficient bark for 50,000 lbs. of quinine. In the South if the planters raised their grade of bark 5 per cent it would pay, but the culture in the South was rapidly going down. There would be no difficulty in manufacturing 100,000 lbs. at the two factories, given the facilities. If quinine was required for 30 million people, there would be difficulties and it would be necessary to go into the open market; that would send up the price considerably. The world's total output of quinine was a million pounds and that figure has been stationary for some years.

Sir Harold Stuart in reply to a point raised, explained that local Governments were not allowed to go into the open market for quinine.

Captain Gage said that it was not possible to get better quinine in India than that turned out in the Bengal factory. Should it be required, there would be no difficulty in turning out hydro-chloride, but it would be half as expensive again.

Sir Harold Stuart observed that it had already been explained that the price of Government quinine was based on the price of quinine in the previous year. It had to be remembered that the price of quinine was affected by the existence of the Government factories and the view held by the Government of India was that it was not asking too much of local Governments that they should be prepared to pay a somewhat higher price as an insurance against a rise in the price of quinine.

Mr. Nathan thought that any measures in connection with obtaining quinine in the open market should be conducted by the Government of India; it would be most inconvenient for the local Governments to compete against one another in the local markets.

Captain Gage said that they could turn out a certain amount of hydro-chloride for experimental purposes; they might turn out 5,000 lbs. The cost would not be very much. Sulphate was made in the first instance and had to be converted into hydro-chloride.

The President presumed that hydro-chloride was to some extent experimental. It seemed undesirable to start plant in Government factories if there were any uncertainty in the matter.

Sir Harold Stuart remarked that the Government factories would be fully occupied in turning out sulphate, and hydro-chloride should therefore be obtained in the open market.

Captain Gage said that they charged the Jail Department wholesale rates; the cost price was Rs. 7 per pound. The rate at which it was sold was Rs. 10; he said that there was a profit of Rs. 3 on the pound, but the profit was wholly swept away by the pice packets.

The President then read out to the conference the rough drafts of recommendations and resolutions on which he invited suggestions. The discussion which followed was concerned only with changes in phraseology.

SIXTH DAY.

Monday, October 18, 1909.

PRESENT.

The Honourable Sir Herbert Risley, K.C.I.E., C.S.I., I.C.S., *President.*
Sir Harold Stuart, K.C.V.O., C.S.I., I.C.S.

The Delegates.

The President read the following paper :—

Popular co-operation in the prevention of Malaria.

BY

THE HONOURABLE SIR HERBERT RISLEY, K.C.I.E., C.S.I., I.C.S.

At first sight it seems preposterous that any Conference, however well equipped for the purpose, should dream of handling the problem of malaria within the inside of a week. That is what the outside critic, not necessarily familiar with the literature of the subject, might naturally be expected to say. But in reality the scientific portion of the field has been very thoroughly prepared for us by the enquiries of Laveran, Manson, Ross, Grassi, Schaudinn, Koch, and many other labourers in the region of original research. They have explored and discovered, and it is for us to profit by the lessons which their discoveries teach. When we come to administrative measures, to the vital question how knowledge should be translated into action, and applied so as to relieve the immense mass of human suffering that is caused by malaria—here again we are not without much instructive experience. The problem is not a new one. Malaria is one of the oldest of Indian diseases. The medical hymns of the Atharva Veda, so ancient that they propound a treatment by means of charms and sympathetic magic, contain an accurate description of the symptoms of the disease in which the various forms of intermission are distinguished, and the characteristic accompaniment of jaundice, especially during the rainy season, is carefully noted. Several centuries later the Ayurveda designates malaria as the "king of diseases" and prescribes less primitive remedies. Better evidence of antiquity would be hard to find. Through all these ages men have been endeavouring, by such means as they could devise, ranging from the magic of the Atharva Veda down to the microscopes and cultures of our own time, to discover the causes of the disease and the methods of avoidance and cure. And I think some recognition is due to these forgotten workers. They were hampered by erroneous theories ; they had none of the scientific technique that is now available ; nevertheless they did good service in their day, and they arrived by empirical paths at various practical conclusions which we cannot afford to despise.

We have now come to the end of our deliberations. Some interesting and valuable papers have been read ; all aspects of the question have, I think, been very thoroughly discussed ; and I am not without hope that our conclusions may form a useful basis for further action both as regards scientific research and administrative measures. We do not pretend to have said the last word on the subject. Scientific enquiry must continue, and for this we suggest an organization which will secure that all new ideas shall be fully examined and discussed by competent authorities. As to executive action, we recommend that this should be directed to the extirpation of mosquitoes, wherever this is found to be reasonably practicable, and to the promotion of the use

of quinine. We have endeavoured to indicate the lines that should be followed in each case. In the course of our discussions we have profited greatly by the presence of Indian gentlemen representing various provinces, and I desire to take this opportunity of acknowledging their services and thanking them for the valuable advice they have given us. This has led me to consider how co-operation such as we have received from them can be secured, in an organised fashion and on a much larger scale, for the measures that all of us have at heart. I am sure you will agree with me that it is out of the question that even the comparatively modest and tentative operations that we recommend should be carried out effectively by any official machinery that it is possible to contemplate. Even if we had, as I hope we may have some day, a complete sanitary service, or rather a graduated series of sanitary services—trained sanitarians, trained engineers, trained inspectors, most, if not all of them, Indians—we should still be unable to touch more than the fringe of the subject. In the first place, the cost of an official agency that should carry sanitation into the small towns and villages of India is bound to be prohibitive. I need not dwell upon that difficulty. Secondly, every rupee spent on establishments means a rupee less for the preventive and curative measures which are the real essentials. Thirdly, and this is perhaps the most important point, any operations that will make an appreciable impression on malaria—drainage, clearing jungle, removing puddles, filling tanks, administering quinine, whatever they may be—involve a degree of interference with the daily life of the people, their domestic affairs, their interests, their prejudices, and their superstitions, that no official agency can embark upon without incurring the gravest risks. The first condition of success is that the people must help us, for only by helping us can they help themselves. Are they capable of doing this at present? I think not; they must be taught; we look to their natural leaders to teach them; and I am confident that we shall not look in vain. It is almost an impertinence on my part to submit to the Indian members of this Conference a sketch—a very rough sketch—of the sort of organisation that perhaps might deserve their consideration. But what occurs to me is that, when the new Legislative Councils are constituted, the non-official members might take in hand the question of malaria. There will be in every province members representing territorial areas, divisions, sub-provinces, or groups of districts. I suggest that in each such area the member should form, and should himself preside over, a committee including all the leading men,—landholders, bankers, merchants, lawyers, professors and schoolmasters, journalists, doctors, in short every one of influence—and that they should initiate and carry on a systematic campaign against malaria. For each district there would be a similar committee, its president being a prominent municipal commissioner or an active member of the district board. They in their turn would see to the formation of committees in sub-divisions, tahsils, taluks, whatever the local unit may be, and we may hope that in course of time the organisation will be brought down, if not to the village, at any rate to groups of villages. If you ask what should they do, I would answer what could they not do? They would be in the closest touch with all ranks of the people; they could teach; they could persuade; they could do all the things that an official agency would attempt in vain. They would induce men of means to re-excavate the tanks which the piety of an earlier generation constructed; they would remind the absentee of his obligations to his ancestral village; they would initiate minor schemes of drainage; they would organise private charity for the provision of quinine, and above all they would bring home to the people that there are many simple measures which tend to avert malaria and that their only chance of escaping the disease is to carry out these measures for themselves. In such propagandism the public spirit of Indian journalists would find unlimited scope. That is a rough outline of the lines on which the committees might work. The difficulties in front of them are obvious; but I can see no other way in which they can be surmounted; and I am confident that the Indian members of this Conference will agree with me in regarding the question as one of the highest national importance.

ThePresident then read the provisional conclusions arrived at as a result of the discussions on the previous days and invited suggestions.

The following discussion ensued :—

In regard to investigation of the epidemiology of malaria.

Colonel Thornhill observed that they had not got the full history of any of the malaria bearing mosquitoes, nothing was known of their habits, where they hibernated, etc., and he thought it was important to get these particulars.

In regard to the question of vital statistics :

Colonel Dyson said that in Bombay the village was the unit and not the *thana.*

Major Rogers said that in Bengal the figures for villages were all combined together in the *thana* ; they should be sent in separately to the Sanitary Commissioner's office where they would be available for enquiries such as Captain Christophers had carried out.

The President thought that the Conference might record that the *thana* was considered to be too large an area for the purpose and might suggest that smaller units should be made use of.

Captain Christophers observed that there would be great difficulty in going lower than the *thana.*

Colonel King said that in Madras the unit was a population of 5,000 and that in cases of large numbers the figures were grouped.

Mr. Fox-Strangways remarked that in the Central Provinces the village statistics were recorded in the *thana.*

Mr. Maude stated that in Bengal there were no statistics in the village, they were recorded at the *thana.*

Mr. Ferard said that in the United Provinces figures were given to the Sanitary Commissioner's Department according to sanitary circles.

The President suggested that local Governments might be asked to consider the question of recording their vital statistics by such local groups as would best illustrate the distribution of malaria. Some natural grouping was required.

In regard to the Agency by which investigations should be made.

The President said that as regards the appointment of officers to carry out investigations sometimes the Central Committee or the Government of India would do this on their own initiative. Suppose again it was generally agreed that an enquiry into the prevalence of malaria was to be held in a particular part of Madras, the local Government might point out that they had a competent officer whom they proposed to employ. In that case there would be no objection to his employment. If on the other hand no suitable officer was available locally one would be sent. Investigators employed in a province would work in accordance with methods laid down by the Central Committee. Local organisations would correspond direct with the Central Committee but would in no way be under the orders of that body.

Major Wilkinson maintained that the local organisation was not required.

Some discussion arose on the question whether in connection with a local organisation the Sanitary Board should be specifically mentioned. Mr. Fox-Strangways thought the omission of mention of it would lead to the conclusion that the Sanitary Board was not a suitable local organisation.

Colonel King did not think that the officer who would be deputed by the Government of India should be deputed except at the request of the Local Government.

Mr. Nathan thought this was sound. He then proceeded to refer to the question of the appointment of a special officer under the Sanitary Commissioner of the province. It was necessary to appoint one who would remain long enough to know the province thoroughly. He thought the Central Committee should not send

officers to carry out investigations apart from the schemes of the local Government. They should consult the local Government. It should be a provincial organisation with the Deputy Sanitary Commissioner at its head and the provincial organisation should seek and utilise the services of the Central Committee.

Colonel Leslie pointed out that that was precisely the aim of the scheme.

The President put the case of a new discovery with regard to malaria being made in Europe. If the Central Committee desired to have the question investigated and the area in which that could be best done was situated in some province could not the Committee send the officer without the permission of the local Government ?

Mr. Nathan replied that that would be a special case. If special circumstances arose it would be for the Government of India to issue instructions.

Sir H. Stuart said the officer would not be under the orders of the local Government. The whole of India was not to be shut against scientific investigation.

Mr. Nathan saw no objection in a special case of the kind but he thought the control of anti-malarial operations in each province should be in the hands of a special officer subordinate to the Sanitary Commissioner of the province.

Major Rogers said it was most essential that the officer should be permanent and under the local Government. At the same time they would be only too glad to have the aid of any additional officers sent by the Government of India.

Mr. Nathan pointed out that the provincial officer would, under the Sanitary Commissioner, conduct the preliminary statistical enquiry, select the special localities for investigation and operations and supervise these investigations and operations. This would not preclude the Government of India sending a special officer for its own scientific investigations.

Mr. Weir said that although the evil of malaria was not a crying one in the Madras Presidency still they would be glad to have a special officer.

Major Rogers said that the question was of the greatest importance in Bengal and it was essential to have a permanent man.

Colonel Bate said that the Punjab would be very glad to have a special officer. The officer should be attached permanently for the purpose of investigating malarial diseases.

Mr. Fox-Strangways said the Central Provinces would also be glad to have a special officer.

Mr. Cholmeley did not think there would be any objection in Burma. The special officer might be a member of the Sanitary Board.

Colonel King thought that where the local officer found himself in difficulties, the local Government would doubtless apply for an Imperial officer.

Mr. Ferard agreed entirely as to the necessity of a special officer. In the United Provinces sanction had been given to the appointment for two years of an officer on lines similar to those under discussion.

Colonel Dyson agreed that such an officer was much wanted.

In regard to Practical measures. The Extirpation of mosquitoes.

Sir H. Stuart said it had been urged against the Conference that it was being run entirely in the interests of quinine prophylaxis. He thought the Conference should explain that they were by no means prejudiced in favour of one form of remedial measure rather than another. The extirpation of the mosquito was undoubtedly the best remedy that could be adopted for getting rid of malaria and the conference should make it clear that in some parts of India they recommended resort to the less satisfactory method of quinine because they were forced to do so by the local circumstances. He was amazed at the quantity of quinine that would be required for either the prophylaxis or curative treatment. For 100 million people

they would require three times the entire world's production. Moreover, if the demand increased even by half a million pounds the price would go up and increase the financial difficulties.

In regard to the resolution dealing with measures in urban areas.

The President explained that it was not intended to compel every small town to provide an expensive system of surface drainage if there was no reason to suppose that the drains were the breeding places of mosquitoes. But in places there were badly aligned surface drains with puddles and deep hollows and these were breeding grounds ; it was in such places that proper surface drainage might be gone in for, if money were forthcoming.

In regard to the resolution dealing with measures in rural areas.

The President happened to know that in a certain district in the south of Bengal they had a very ancient, elaborate and effective system of village drainage. There were hundreds of miles of embankments and the result was that they got accumulations of water. Subsidiary to the rivers and large drainage channels there was a regular system of drains. Once upon a time these were effective but had now silted up. These were the sort of cases that the Resolution was directed to.

In regard to the resolution dealing with the lowering of a high subsoil water level.

The President said that the Conference would not recommend the expenditure of large sums of money on drainage schemes of doubtful utility, but every scheme should be considered on its merits. Before it is undertaken there should be reasonable evidence that the construction of the work would result in the abolition of the breeding of the anopheles mosquito. He went on to describe the position in Nadia, Jessore, Murshidabad and other parts of Bengal where there had been a complete change in the lines of drainage. Wild schemes had been put forward as to what might be done with immense sums of money to restore the original condition of the district. These were hopelessly impracticable and he thought it would be well if the Conference were quite clear on the point. At the same time they were not precluded from recommending smaller schemes. It was conceivable that in Jessore they might by a cutting restore a dead river into a live one at a reasonable cost ; this was to be recommended in place of the gigantic proposals suggested by irresponsible advisers. It was to be hoped that the result of the scheme undertaken in the 24 Parganas under the Drainage Act would be watched before any similar scheme was put in hand.

Major Rogers briefly explained the scheme and said that no other was in contemplation.

Colonel Bate said that in the Punjab very extensive tracts had been drained with great benefit to the people and so far as he was aware there was hardly any desire on the part of the people greater than one to be relieved from the suffering inflicted by imperfect drainage. Mr. Jacob had explained what had been done along the Western Jumna Canal and he (the speaker) could speak from personal observation of the results attained in other parts. As the result of drainage in Sirsa the health of the people had improved and they had been enriched by being able to utilise land that was formerly valueless. He believed that a Resolution was passed during the Viceroyalty of Lord Dufferin that Local Governments should undertake drainage schemes. It was said by the Government of India that there was no way in which the funds available for sanitation works could be better expended. Personally he was of opinion that there was no measure better calculated to relieve the people of the existing evil than drainage.

The President asked if it was not the case that in Karnal and Rohtak waterlogging had been produced by artificial means.

Mr. King said that that was not the case in Sirsa.

Colonel Bate said that waterlogging along the Western Jumna Canal was due to percolation from the channel ; the alignment was bad. An attempt was

made in each case to find out if the defect was remediable. Each case must, as the President had remarked, be treated on its own merits. The matter should be left entirely to local Governments and they might be trusted not to embark on impracticable schemes, but they should not receive any sort of discouragement. He had an intimate knowledge of the configuration of many parts of the Punjab and he would say that there were vast areas where the country could be thoroughly drained and the health of the people improved. In many places the schemes could be made remunerative and the land made productive. He would go so far as to say that in a large number of cases the cost of the drainage schemes could be defrayed from the sale of land that would be cultivated afterwards.

Mr. Nathan was satisfied with the Resolution that had been read out by the President. Great caution would be required because of the cost of such undertakings.

Colonel King agreed with the remarks made on the subject of drainage. He especially agreed with Colonel Bate's remarks that there had been neglect of the question of the benefit to agriculture that might accrue from drainage operations. So he had very little to add to the Resolution except to ask that some modification might be made in the wording of the sentence relating to subsoil drainage. He hoped that it would be understood that he was not an advocate for rash declarations that drainage and nothing but drainage was necessary. He was aware that finance had limits. In his opinion for permanently getting rid of the anopheles there was no measure that could equal that relating to the drainage of surface and subsoil water.

Mr. Ferard mentioned that there were certain places just below Kosi about the most malarious in the United Provinces where there were numerous tanks. These were drained two or three years ago. There was no doubt that when a Municipality or District Board carried out a drainage scheme it required the very best expert advice. Such advice could be obtained only from the expert engineers of the local Government and at present the local Government had the right of charging a certain commission for the loan of an officer's services. He thought it might be mentioned that these services should be given free considering the value of drainage in malaria.

Mr. Lawrence said that parts of Bombay were waterlogged and this was induced by canals having obstructed the natural lines of drainage. This should be avoided in future.

In regard to the prohibition of wet cultivation.

Mr. Weir said that wet cultivation was shown not to be the cause of malaria in many places. In Madras houses occupied by Europeans were surrounded by rice cultivation and this caused no malaria. In the Godavari and Kistna deltas the same thing occurred.

Mr. Narayanamurti agreed that in the parts with which he was acquainted there was no connection between wet cultivation and malaria.

Mr. Goswami desired to add something to the effect that where it was established that malaria in a town was due to anopheles breeding in wet cultivation in the immediate vicinity of the town the cultivation should be restricted and prohibited whenever possible. He could not claim to be an authority on the question but in view of what had been said during the discussion he felt bound to put forward this proposal. Local authorities should have the power to frame bye-laws in the matter.

Colonel Bate, *Mr. Nathan* and *Mr. Fox-Strangways* supported the proposal.

In regard to the clearance of jungle and the thinning of trees.

Mr. Ferard gave an instance of a town surrounded by trees where the ventilation was much impeded. This was said to be a place where mosquitoes bred in numbers. Legislation was being framed for dealing with excessive tree growth. At present they had power only to deal with undergrowth; sanitary experts said that pools of water formed at the foot of trees.

Major James observed that to give the impeding of ventilation as a reason for recommending the thinning of trees would be unfortunate, because malaria is not caused by lack of ventilation. The presence of trees led to a lowering of the subsoil water and a belt of trees between breeding places and habitations might be of great service. It would be a pity if the Conference made a recommendation which might discourage the planting of trees near towns and cantonments especially in the drier parts of the country.

In regard to the measure of Oiling.

Major Rogers said that after considerable experience he did not think the plan was any good. The treatment with petroleum should be restricted to small collections of water which contained the larvae of the anopheles mosquito and could not be filled up. Wells should not be treated with petroleum but should be covered wherever this was possible.

Mr. Sundar Lal and several of the other Indian delegates thought it would be better not to interfere with the wells.

Colonel Bate said that in Khartum great benefit was derived from covering up wells. The results were contained in a review written on the subject by Dr. Balfour.

In regard to the recommendation dealing with Fish.

Mr. Weir thought the idea put forward in the draft Resolution was a very good one. In Southern India the paddy fields swarmed with little fish.

In reply to the President all the delegates said that they were prepared to accept the proposal.

In regard to the resolutions dealing with quinine treatment and prophylaxis.

Mr. Lawrence thought that cinchona plantations should be increased; at present there was a danger of shortage.

In regard to the resolutions dealing with education.

Mr. Narayanamurti was very strongly in favour of the Resolution of this subject. In connection with small-pox and vaccination all scholars were required to pass an examination on the points laid down in the text book and the mosquito malaria theory should be also included in the text book. He had himself only recently learnt this theory and as even educated persons were in ignorance of it, it was most necessary that knowledge on the point should be disseminated as widely as possible.

Mr. Goswami said he was in favour of the Resolution. He would also add that sanitation and hygiene of an elementary character should be taught in boys' and girls' schools. Leaflets should be distributed.

Major Rogers said that elementary hygiene was being taught in schools in Bengal.

Colonel King said that there was no more powerful method of educating the people than for them to be in contact with Sanitary Inspectors, men who understood sanitation and who were of such high caste that they mingled with the people without any fear of contamination. He gave figures of cost which he had worked out. He moved that the Conference should record the opinion that both in rural and urban areas it is essential that the control of all routine anti-malarial measures should be in the hands of the permanent staff—a constituted

organised sanitary service. He considered that special sanitary measures could not be dissociated from ordinary methods.

The President suggested that the matter might come under Finance.

Mr. Ferard thought the important point was to invite the co-operation of private medical men in the campaign.

Colonel Lukis said that this was being done in Bengal.

The President agreed that it was very necessary.

Mr. Mudholkar attached great importance to the issue of pamphlets and leaflets written in simple English on the subject of hygiene and all the matters that had come before this Conference. These could be translated and issued also. The people had been asked to come to the aid of Government; he believed that they would heartily respond to the efforts that Government was making.

Mr. Nathan thought that in the case of children it would be for the Department of Public Education to arrange for them to be taught such lessons as village sanitation and the like.

Colonel Dyson said that in Bombay there was a sanitary primer but the teaching had largely failed because there was no guarantee that the teachers understood what they had to teach.

Mr. Mudholkar said that he attached great importance to the association of the educated classes in this great work of mercy upon which the Government were engaged. Reference had been made to uncharitable criticism. He said it was a matter of humiliation to them and he would ask Government not to pay any heed to such criticism.

Mr. Narayanamurti quite agreed with the last speaker. He was sure that Government which was always so solicitous of the welfare of the people would spare no expense in the carrying out of these measures. There should be in all the work suggested the hearty co-operation of the educated people, with the Government in their benign efforts.

Mr. Goswami said he was in entire sympathy with the Resolution. In recent times the tendency was for Government to associate officials with non-officials in any undertaking where this was possible. This association always led to great good. In the case of combat with malaria some of the liberties of the people might have to be restricted and regulations would have to be passed and this association was therefore the more necessary, and it would come to the people as having the sanction of those who belonged to them.

In regard to the resolution dealing with the Sanitary Staff.

Colonel King moved his proposal on the subject of the *control of routine anti-malaria measures*. He wished it to be understood that the executive grades of such a service would be under the local authorities.

Mr. Cholmoeley was in entire agreement with the proposal.

Mr. Sundar Lal was also in agreement. He explained that at a Conference last year in the United Provinces a similar Resolution was passed; the suggestion was that there should be an Assistant Surgeon who was to help the Civil Surgeon, with Inspectors wherever necessary.

Mr. Maude said that the appointment of Inspectors was made compulsory on District Boards in Bengal. The enquiries of the local Government were not as yet quite complete but the opinions received seemed to point to the recruitment of men of the class of Assistant Surgeons.

Sir H. Stuart said that the Sanitary Inspector was the creation of the Madras Government. He was not allowed to go to rural areas as it was thought he might become another agent of oppression. The Government of India lately addressed local Governments on the subject of a Sanitary service and they especially refrained from raising this question of a Sanitary Staff in rural areas as it was believed that there would be strong objections on the part of the people.

Mr. Nathan agreed with Sir H. Stuart and he thought that Colonel King's proposal would carry them to dangerous lengths. Possibly some increase in the superior inspecting staff would be called for. As regards towns it seemed unnecessary to pass any Resolution; the increase of the organisation of a sanitary staff was already under consideration. As regards rural areas an officer was needed in special localities selected for experimental operations. As regards districts the most that was required seemed to be the appointment of an Assistant Surgeon for supervision under the Civil Surgeon of the District.

Colonel King said with reference to Sir H. Stuart's remarks that the whole question of money dealing was gone into by the Madras Government and it was concluded that in no case had the men departed from sound moral conduct. He claimed that his scheme was an economical one and that in addition registration duties could be performed.

After some further conversation and some alteration in the wording of the Resolution with a view to putting it in more general terms, Colonel King said that as finally drafted it would cover his point.

In regard to the resolution dealing with Finance.

Sir H. Stuart said that it seemed to him that the case was almost entirely one for local taxation. The disease was local, the results of it, economic and otherwise, were local, and the benefits of prevention and cure would be local. This was essentially a case therefore where the financial burden of the proposed measures should be local. He thought if it was brought home to the ryot that the funds raised from an additional cess were to be devoted to relieving him of a grievous burden he would agree to bear it. He had accepted other taxes of a similar nature, such as the cess for construction of local railways although the benefits in that case were only indirect as a rule.

Colonel King held that malaria was very far from being only a local danger. Mosquitoes carried the germ far and wide and in the case of emigration of coolies the disease was carried to various centres. Again he regarded the whole of the infected area not as one where further taxes should be levied but rather one where provincial funds should be contributed.

Mr. Narayanamurti said the ryot would not believe that he could get any benefit from a cess and would consider the imposition of additional taxation as a great hardship. As regards the railway cess he got back the money.

Mr. Goswami said that there was no railway cess in Bengal.

Mr. Narayanamurti said that perhaps the educated classes might agree to it and in towns and municipalities he did not think there would be much opposition but the ryots who lived in great poverty in malarial tracts would consider it a great burden.

Mr. Goswami gave some particulars of the cesses at present levied in Bengal; he thought that District Boards in Bengal, unlike those in other Provinces, did not get the full benefit of the local cess that was realised from ryots and landlords. The road cess had been earmarked for the purpose of improving means of communication and for water-supply. If the Public Works cess were localised and made available for district boards it is certain that a great number of sanitary improvements could be effected. He held that poverty was accountable for malaria, poverty reduced the people's power of resistance and if further taxation was to be imposed then that resistance would be further reduced. He went into some detail as to the high holding tax, the latrine and the water tax and stated that if an addition was to be made to all these taxes it would be felt to be a great burden.

Mr. Mudholkar opposed an additional cess on the same grounds as those advanced by Mr. Goswami. There was an additional objection, namely, that all the feelings of gratitude in the minds of the people would vanish. The District Boards were at the end of their finances and the same was the case with Municipalities. They would have to find funds to improve the water-supply and drainage, and fresh taxation on this account would be necessary; if therefore a malaria cess were imposed it would be considered a great hardship. Money should come from Provincial and Imperial funds.

Mr. Sundar Lal explained in detail the method of taxation prevailing in the United Provinces and concluded by saying that he felt that funds for the proposed measures should come from Provincial revenues.

Mr. Lawrence saw no objection to the plan provided it was only permissive.

Sir H. Stuart said he would not press his suggestion against the views of the Indian Members.

Colonel King moved that for the correct investigation of drainage measures directed against malaria it was essential in each province that the officer undertaking the investigations should have the aid of an expert drainage engineer with an adequate staff.

The President saw only financial objections to the proposal. On the motion being put to the vote it was lost, the voting being For—9; Against—16.

The President : Gentlemen, it only now remains for me to thank you for the time and trouble you have devoted to this question and to express the hope that the Proceedings of this Conference will bear fruit in the future and be taken seriously, and above all that we may get the very considerable sums of money that our proposals will demand. The Conference is now closed.

RESOLUTIONS AND RECOMMENDATIONS.

I.—Scientific Investigations.

1. That the Conference is much impressed with the need of further knowledge of the following subjects and recommends that steps be taken without delay for their systematic investigation :—

(1) The distribution of malaria.

(2) The epidemiology and endemiology of malaria including (*a*) meteorological and physiographical conditions, and (*b*) the life history of malaria bearing mosquitoes.

(3) The physiological and therapeutical action of quinine and other remedies for malaria.

2. A critical examination of the vital statistics of each province should be undertaken with the object of ascertaining the different degrees of prevalence of malaria and the areas which may be regarded as typical for the purpose of further test and investigation. In this connection the Conference invites attention to the researches conducted by Captain Christophers in the Punjab.

3. Vital statistics are now collected by villages and are compiled by areas such as *thanas* and *taluks* which are often so large as to obscure the true distribution of malaria. The Conference are of opinion that local Governments should provide for compilation by some smaller units such as, villages, village unions, *zails*, patwari's circles, etc.

The figures thus compiled need not be published but should be kept on record at convenient centres.

4. The Conference considers that the existing vital statistics of provinces will throw much light on the distribution and relative prevalence of malaria if the figures for fever are corrected by the results of test enquiries in selected typical areas. Such test enquiries should be carried out in every province by a special staff under careful supervision.

5. Where investigations into the epidemiology and endemiology are undertaken, special attention should be paid to tracts in which malaria is not endemic with the object of discovering the reasons why such localities are free from the disease.

II.—Agency by which investigations should be made.

1. The Conference having learnt that the Government of India will appoint a Central Scientific Committee to direct and co-ordinate investigations, and that they will also appoint at the request of local Governments or on the recommendation of the Central Committee officers to carry out investigations, recommends that a local organization to work in consultation with this Central Committee be constituted in each province. The nature of such organization should be settled by the local Government and may take the form of the Sanitary Board.

2. A Conference consisting of the members of the Central Committee and a delegate from each local organization should be held annually at such place as may be convenient for the purpose of reviewing the work done and preparing a programme of future work.

III.—Practical Measures.

A.—Extirpation of mosquitoes.

1. As the extirpation of the anopheles mosquito is obviously the most complete and satisfactory solution of the malaria problem, the Conference recommends that investigations be continuously carried on with the object of ascertaining by what methods this can best be done at a cost which is not prohibitive.

2 The Conference makes the following recommendations regarding the measures for extirpation or reduction of mosquitoes which have been placed before them :—

1. *Drainage.*

(*a*) In urban areas where the existing surface drains are found to be the chief breeding place of anopheles mosquitoes, a properly graded surface drainage is a most important anti-malarial measure.

(*b*) Though in rural areas the construction of any system of masonry drains is impracticable on account of the cost, yet it is advisable to improve the surface drainage in malarious localities by removing obstructions and filling up depressions in which water stands and anopheles mosquitoes are known to breed.

(*c*) Both in villages and towns the lowering of a high sub-soil water level when practicable is an anti-malarial measure of primary importance.

The deliberations of the Conference have shown that it will not be possible to protect rural areas by any scheme of drainage which is financially practicable, but it has been found that in some highly malarious tracts the level of sub-soil water has been materially lowered with great permanent benefit by drainage operations the cost of which was not prohibitive. Similar schemes should be investigated in each province for highly malarious localities.

(*d*) The Conference is unable to make any general recommendation regarding the prohibition of wet cultivation in close proximity to dwelling houses, for while there is evidence of good results having been obtained by that measure in some localities, there is also clear evidence that malaria is in no way a necessary consequence of irrigating land near towns and villages. Every case of the kind requires separate investigation.

When it is established that malaria in a town is due to anopheles mosquitoes breeding in wet cultivation in the immediate vicinity, such cultivation should be prohibited or restricted whenever possible.

(*e*) In Italy some success has been attained in filling up marshes by turning rivers on to them and thus reclaiming them by successive deposits of silt, and the Conference draws attention to this method.

(*f*) The clearance of jungle and the thinning of over dense tree growth are desirable in all places in the neighbourhood of habitations where these conditions impede drainage and shelter mosquitoes.

2. *Oiling.*—Treatment with petroleum should be restricted to small collections of water which contain the larvæ of anopheles mosquitoes and cannot be filled up, or drained.

3. *Fish.*—It should be ascertained by enquiry and experiment whether the breeding of anopheles mosquitoes is greatly checked by the presence of fish in tanks and other collections of water; and if this is found to be the case, endeavours should be made to introduce suitable fish where their presence is likely to prove beneficial, and to afford protection to them where they exist.

B.—Quinine treatment and prophylaxis.

(1) The Conference adopts the conclusions of the sub-committee, whose report is on page 77, regarding the quantity of quinine required (i) for treatment of malaria and (ii) as a prophylactic.

(*a*) Quinine should be given in the form of sulphate or hydrochloride for adults :

(*b*) for children some palatable form, such as tannate, is recommended.

(2) Generally speaking, the method of selling quinine by treatments is to be preferred to that of selling by the dose, but in order to meet the wants of the poor it is advisable that both systems should be maintained. It is suggested that the ordinary size of the tablet should be one of five grains, which is the proper prophylactic dose for adults.

(3) The agency for the sale of quinine should not be limited to postmasters but the services of all grades of officials should be utilized; special attempts should be made to induce private vendors to engage in the business; and the educated classes should be asked to organize means of spreading a knowledge of quinine among the lower classes. The rate of commission should be liberal.

(4) In order to disseminate a knowledge of quinine as widely as possible, recourse may properly be had to moveable camps, itinerant dispensaries, leaflets, notices and advertisements, especially in the vernacular papers, and to teaching in all grades of schools.

(5) The free distribution of quinine should as a rule be resorted to only in the case of severe epidemics. This rule will be open to exceptions at the option of local Governments, especially in backward tracts where quinine is unknown, and in the case of school children in malarious tracts and during the malaria season for prophylactic purposes, provided that arrangements can be made to secure that the quinine is actually taken.

(6) General measures of quinine prophylaxis, such as the sale of Government quinine by all available agencies and the dissemination of a knowledge of the benefits it confers, should be carried out as widely as possible. More specialized and expensive methods, such as moveable camps and the distribution of free quinine to adults and children, should ordinarily be confined to selected areas.

(7) The Conference is informed that the maximum output of the Indian factories is limited to 100,000 lbs. of sulphate of quinine, which would be sufficient to treat about three million people; and that the world's supply has for some years been stable at one million pounds, or enough to treat about thirty millions of people. These facts have an important bearing on the possibility of treating malaria by quinine. In the event of the supply from the Government factories proving insufficient, it will be necessary to purchase quinine in the open market. In any case the Conference think hydrochloride of quinine should be procured by purchase and should not at present be manufactured in the Government factories.

It is desirable that the area under cinchona should be increased.

C.—Education.

(1) The local organization in each province should frame a scheme for instructing the inhabitants of malarious tracts regarding the main facts connected with malaria. Such instructions should be given by lectures, illustrated if possible by magic lantern slides, and by leaflets, and pamphlets in the vernacular languages. Private medical practitioners should also be invited to disseminate a correct knowledge of the subject.

(2) The Education Department should arrange to include in text-books, lessons on malaria and hygiene, and to give similar instructions in normal schools.

(3) The Conference strongly recommends the constitution of divisional and district committees of the nature suggested by Sir Herbert Risley, and of local societies similar to the league started by Mr. King with such success in Gurdaspur. Such committees and societies should consist of both officials and non-officials.

D.—Sanitary Staff.

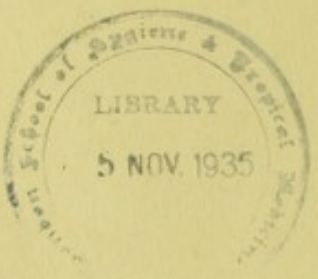
It is desirable that the Sanitary Department should be organized with reference not only to general sanitation, but also to the suppression of malaria.

E.—Finance.

(1) Each local Government should be invited to make a special allotment of funds every year for the investigation of the problems connected with malaria and measures of prevention.

(2) The Conference recognize that the amount of this allotment will depend upon the state of the provincial finances, but they would urge that the prevention of malaria has a strong claim upon all surpluses and increases of revenue.

(3) Municipal Councils and local Boards should also be urged to set apart funds for the prevention of malaria.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