Papers relating to the investigation of malaria and other tropical diseases and the establishment of schools of tropical medicine.

COLONIES: MISCELLANEOUS.

PAPERS

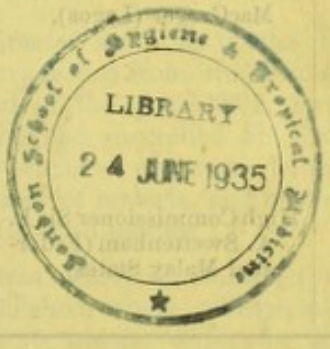
RELATING TO THE

INVESTIGATION OF MALARIA AND OTHER TROPICAL DISEASES

AND THE

ESTABLISHMENT OF SCHOOLS OF TROPICAL MEDICINE.

Presented to both Houses of Parliament by Command of His Majesty.
June, 1903.



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PAPERS

RELATING TO THE

INVESTIGATION OF MALARIA AND OTHER TROPICAL DISEASES

AND THE

ESTABLISHMENT OF SCHOOLS OF TROPICAL MEDICINE.

CIRCULAR.

MR. CHAMBERLAIN to the GOVERNORS of all COLONIES.

SIR, Downing Street, May 28th, 1903.

DURING my term of office I have addressed to the Governors of the tropical Colonies various circular despatches on medical and sanitary subjects, more especially in connexion with the investigation of malaria and the training of medical officers in the treatment and prevention of tropical diseases.

In the present despatch I wish to summarise the steps which have been taken and the results which have followed, and also to make some suggestions as regards the future.

2. The great mortality among Europeans in such climates as those of the West African Colonies and Protectorates had not failed to attract my notice from the first as it had that of my predecessors in office, and towards the end of the year 1897, largely through the interest taken in the matter by Dr. Manson, who had succeeded Sir Charles Gage-Brown as Medical Adviser of the Colonial Office, my attention was more definitely directed to the importance of scientific enquiry into the causes of malaria, and of special education in tropical medicine for the medical officers of the Crown Colonies.

3. In pursuance of the second of these two objects it was clearly advisable (*a*) that a special training school in tropical medicine should be established, where officers, newly appointed to the medical services of the Colonies and Protectorates, might be given systematic instruction with special facilities for clinical study, before leaving England to take up their appointments, and where doctors already in the service might, when on leave, have opportunities of bringing their professional knowledge up to date; (*b*) that all the leading medical schools in the United Kingdom should be invited to give greater prominence than hitherto in their schemes of study to tropical medicine; (*c*) that the medical reports periodically sent from the tropical Colonies and Protectorates should be re-cast on one uniform type, designed to throw light on the diseases which are most prevalent in tropical countries, and to indicate the methods likely to be most successful in preventing or curing such diseases.

4. With reference to the first of these three objects, the provision of a special training school, it was considered that the Albert Dock Branch of the Seamen's Hospital, which was about to be enlarged, was likely to offer the facilities required, standing as it does at the dock gates, admitting sufferers from tropical diseases direct from ships from

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all parts of the world and being moreover within easy reach of the Colonial Office and therefore likely to be in close touch with that office. These considerations decided me to approach the managers of this hospital in preference to endeavouring to make whatever arrangements might be possible for attaining the object in view, at the Royal Naval Hospital at Haslar or the Royal Victoria Hospital for soldiers at Netley, at which latter hospital officers of the Indian Medical service receive instruction in tropical diseases.

5. On the 2nd of February, 1898, a letter was by my directions addressed to the Committee of the Seamen's Hospital Society, asking whether, in the enlargement of their branch hospital at the Albert Docks, it might not be possible to provide accommodation for the contemplated tropical school. The letter stated that it was not probable that more than six officers would be under instruction at any one time, and that the course of instruction should last for three or four months. The committee of the hospital were asked on what terms and conditions they would be prepared to make the necessary arrangements.

6. Answering on the 16th of April the Committee stated their opinion that there was in the society's hospitals and dispensaries clinical material for the study of tropical diseases which could not be found elsewhere in the United Kingdom in the same amount and variety. They estimated that, if a school for tropical diseases was to be formed in connexion with their branch hospital at the Albert Docks, it would be necessary, instead of enlarging the number of beds as they had already arranged from 18 to 30, to raise it to 45; that this new wing would cost in construction approximately £10,000, and in maintenance £2,000 per annum, and that the school buildings would cost in construction approximately £3,500, and with six students to be resident on the premises, in maintenance £1,100 per annum. They suggested that the fee for a course of not less than 4 weeks should be

	£	*s.*	*d.*
Resident students per week	4	4	0
Non-resident students per week	2	2	0

and they added that they would propose also to admit to the school students other than those sent by the Colonial Office.

7. On the 30th of June following, after communication with the Lords of the Treasury, I was able to accept the scheme which the Committee had put forward, on the terms—

(1) That a contribution of £3,550, the exact sum given in the estimate as the initial cost of school buildings, should be made on behalf of the Colonies and Protectorates concerned;

(2) That the fees should be as stated in the Committee's letter;

(3) That a representative of the Colonial Office should be admitted to the Board of Management of the hospital.

These terms were accepted in a letter of the 14th July, 1898.

To the allotment of the expenditure which was thus guaranteed further reference will be made.

8. On the 11th of March, 1898, I caused a letter to be addressed to the General Medical Council and the leading Medical Schools of the United Kingdom, pointing out the importance of ensuring that all medical officers selected for appointment in the tropics should enter on their careers with the expert knowledge requisite for dealing with such diseases as are prevalent in tropical climates, and stating that, while special arrangements would be made for giving clinical instruction in tropical medicine, it was very desirable that, before undergoing such special training, the future medical officers of the Colonies should be given facilities in the various medical schools for obtaining some preliminary knowledge of the subject. It was added that, in order to encourage the study of tropical medicine in the schools, I would be prepared to give preference, in filling up medical appointments in the Colonies, to those candidates who could show that they had studied this branch of medicine, especially if some certificate or diploma to that effect were forthcoming.

Most of the answers to this letter were sympathetic and encouraging, and the correspondence showed that in upwards of twelve British medical schools, some of them

situated at large seaports, arrangements either already existed or were about to be made for giving special instruction in tropical medicine. A resolution was adopted by the General Medical Council in the following terms :—

> "That, while the Council is not prepared to recommend that tropical medicine should be made an obligatory subject of the ordinary medical curriculum, it deems it highly desirable, in the public interest, that arrangements should forthwith be made by the Government for the special instruction in tropical medicine, hygiene, and climatology of duly qualified medical practitioners who are selected for the Colonial medical service, or who otherwise propose to practise in tropical countries."

9. Meanwhile, on the 2nd of February, 1898, Sir C. Gage-Brown was asked to preside over a committee, the members of which, in addition to himself, were Dr. Manson and three other doctors of long Colonial experience, to consider a suggestion of Dr. Manson's that some uniform scheme for the medical reports of the Colonies should be devised ; that the scientific portions of such reports should be published in a separate volume ; and that the volume should contain an appendix in which would be printed special papers upon the particular diseases of the different Colonies.

On the 4th of July these gentlemen submitted their recommendations ; a model medical report, which they had prepared was sent out to the Colonies in my circular despatch of the 25th July, 1898 ; and, when the replies to the circular had been received, Dr. Manson was good enough, in the light of such suggestions as had been made, to revise the form of the report, which was sent out in its final shape in my circular despatch of 27th April, 1900, with an expression of hope that the model would be conformed to so far as the circumstances of each Colony would admit.

The form is now in general use, though it does not even now receive as full attention as might be wished, and as I hope it will receive in future. The reports, when received, are collated by Dr. Manson, the more important of them being published and presented to Parliament, but the publications would be more valuable if medical officers in the Colonies generally appreciated the object in view as fully as it has in some cases been recognised.

10. When the arrangements had been concluded with the Seamen's Hospital Society for making provision for a School of Tropical Medicine, I wrote on the 6th of July, 1898, to Lord Lister, then President of the Royal Society, telling him of what had been done, but adding that "I am not satisfied to rest at this point and wish to invite the co-operation of the Royal Society in taking further steps." I went on to suggest that a thorough investigation should be undertaken by scientific experts on the spot, into "the origin, the transmission, and the possible preventives and remedies of tropical diseases, especially of such deadly forms of sickness as the malarial and blackwater fevers prevalent on the West African Coast" and that the enquirers should be appointed by and take instructions from the Royal Society. I asked for a grant for the purpose from the funds of the Royal Society, promising that an equal amount would be forthcoming from Colonial funds ; and suggested that a committee of the Royal Society should be appointed to confer with representatives of the Colonial Office on the subject.

The Council of the Royal Society immediately appointed a committee as proposed, and made an initial grant of £300 towards the object in view. The negotiations went forward, and eventually it was decided that two enquirers should be nominated by the Royal Society and one—a member of the Colonial Medical Service—by the Secretary of State, that the whole expenses of the third enquirer should be paid from Colonial funds, and that from those funds a sum not exceeding £2,400 should be contributed towards the expenses of the other two, the Royal Society contributing the balance estimated at £600. The enquirers were to take instructions from a committee, on which members of the Royal Society were to be supplemented by two representatives of the Colonial Office, one of them being Dr. Manson. Thus by September, 1898, arrangements had been made for instituting a School of Tropical Medicine, and a scientific enquiry into malaria.

11. Before tracing further the progress made in each direction it will be well to note how the necessary funds were provided and the expenditure allotted. Of the sum of £3,550, which was guaranteed to cover the cost of building and equipping the Tropical School, the Lords of the Treasury, in a letter dated 18th June, 1898, consented to contribute one half from Imperial funds, "on the understanding that such Imperial

grant will defray the shares of all Exchequer-aided tropical Colonies and Protectorates in such initial cost, and that the remaining moiety thereof will be contributed by other Colonies and the Niger Coast Protectorate." This left to the Crown Colonies, likely to be benefited by the new proposals, to provide £1,775 for the Tropical School and £4,400 for the Malaria Commission, the total cost of which, including the expenses of all three enquirers, was finally estimated at £5,000, of which only £600 would be provided from Royal Society funds.

As the two objects were akin, I decided to ask the Crown Agents to open a common fund, and, taking into consideration what Colonies would be likely to reap most benefit from the proposals if successfully carried out, and what Colonies could afford to contribute most liberally, I invited contributions as under :—

	£
Gambia	200
Sierra Leone	300
Gold Coast	1,000
Lagos	1,000
Niger Coast Protectorate	1,000
Ceylon	650
Straits and Malay States	650
Hong Kong	500
Trinidad	500
Jamaica	500
British Guiana	500
Mauritius	150
Fiji	100

The total asked for was £7,050 as against an estimated expenditure of £6,175, leaving a margin for contingencies. One half of the sum required was invited from the British Colonies and Protectorates in West Africa, as being most vitally concerned in the object to which the money was to be devoted ; and, as the work of the Malaria Commission was expected to extend over two years, it was suggested that the contributions might be made in two annual instalments.

The response from the Colonies was very satisfactory. Ceylon contributed £1,000, the Straits Settlements and the Federated Malay States between them nearly the same amount. Trinidad £700, and all the other Colonies the sums which were asked from them, though I only accepted £250 from Jamaica in view of the condition of the island finances at the time when the money was voted.

Only £150 was asked for from Mauritius, a small sum in proportion to the size and importance of the Colony and to its interest in the schemes. This was due to the fact that the financial condition of the Colony at the time did not warrant a large contribution. Subsequently a further sum of £100 was invited from the Colonial Legislature and readily voted ; and other supplementary contributions—which enabled the work of the Malaria Commission to be prolonged—were £100 from St. Lucia and £50 each from Southern Nigeria, Gold Coast, and British Honduras. The entire management of the fund was left to the Crown Agents, who realised by investments £300, and a statement of receipts and expenditure is appended. It will be noted, on the expenditure side, that some of the money was applied to a supplementary expedition to the Campagna, to which reference will be made hereafter.

Statement.

There are two or three small outstanding claims which have not yet been settled, but it is anticipated that the unexpended balance of the fund will amount to about £150, which might be transferred to the new fund referred to in the last paragraph of this despatch, if the scheme which I propose in that paragraph commends itself to the Crown Colonies and Protectorates.

12. In anticipation of the opening of the tropical school, a circular despatch was on the 19th of August, 1898, addressed to the Governors of Crown Colonies, which enclosed a short memorandum inviting for use in the school the collection of pathological specimens, and any material likely to be of value for teaching purposes. On the 15th of December following, a copy of that despatch was sent to the self-governing Colonies. The 2nd of October, 1899, was named by the Committee of the Seamen's Hospital Society as the date at which the school would be opened. In the meantime, the Committee had consented to an arrangement, subsequently communicated to the Governors of tropical Colonies in my circular despatch of 19th September, 1900, under

which the Managers were prepared to admit into the Society's hospitals at special rates, varying according to circumstances from one guinea to two guineas a week, officers in the Colonial service whose cases were considered to be suitable for treatment as tropical cases, within wards devoted to the special treatment of tropical diseases. The arrangement was to be confined—unless under very exceptional circumstances—to the cases of officers with salaries not exceeding £400 per annum, and the Secretary of State was prepared to guarantee the payments due from such officers, by authorising, if necessary, deductions from their salaries, provided that in each case admission at the privileged rates was made with his knowledge and sanction.

13. The school having been opened, on the 11th of November following, I sent out to the Colonies in a circular despatch its syllabus, and a statement of the rate of tuition fees and the fees for board and residence. The Colonial Governments were invited to concur in the following arrangements for the training of Colonial medical officers :—

(*a*) That all such officers, who might in future be selected by the Secretary of State, should undergo a two months' training at the school.

(*b*) That the cost of tuition, board and lodging during that period should be borne by the Colonial Governments, the officers signing a bond to refund the expenditure in the event of their relinquishing their appointments on other grounds than those of health within three years.

(*c*) That the tuition fees, but not the fees for board and lodging, should be paid by the Governments in the case of medical officers already in the service, who might desire, or be required, to attend a course of instruction while on leave of absence. The cost of tuition fees only for an eight weeks' course was stated at £11 12*s*., and that of tuition, board, and residence for the same term, at £30 17*s*. 4*d*. As these sums were not large, I took upon myself to bring the scheme into operation in anticipation of the concurrence of the Governments concerned, but that concurrence was in most cases readily given, though there was some difference of opinion and practice, more especially as regards payments in the case of doctors already in the Government service.

14. I noted in this circular that a school of tropical diseases had been recently established and excellently equipped at University College, Liverpool, and proposed that medical officers already in the service should have the option of receiving their instruction either in Liverpool or in London, but added that newly-appointed officers would always be sent to the London school. I saw cause in the following year to reconsider this last decision, and to place the Liverpool school on the same footing as the London school, as regards newly-appointed officers also. To this point I will recur later on.

15. It has been found that urgent need for immediate medical aid in one or other of the Colonies from time to time, and especially during the continuance of the war in South Africa, has made it necessary to send out doctors who have not gone through the prescribed course at London or Liverpool, but such omissions are minimised as far as possible. It was found necessary, too, to call the attention of medical officers already serving in the Colonies, who might wish or be required to take a course of instruction while on leave, to the desirability of joining the schools at the beginning of a session. This was done by my circular despatch of 31st May, 1901.

16. I may here notice that, owing to the improvement in the supply of suitable candidates for the West African Medical Staff, steps are now being taken to establish a Reserve of medical officers for the West African Colonies and Protectorates, so that, on the occurrence of vacancies, it may be possible to send out with the minimum of delay doctors who have received a proper course of training in tropical medicine at the London or Liverpool Schools. It is proposed that the doctors selected for the Reserve shall be sent to one or other of the Schools for a full course of three months, that in addition to their fees for tuition, board, and lodging, they shall receive an allowance at the rate of 5*s*. a day for the period during which they are under instruction, and for a reasonable period between the end of the course and the date of embarkation for West Africa. It is also proposed that all doctors, whose fees are paid by Colonial Governments, shall, before proceeding to take up their appointments, be required to pass an examination, or to obtain a certificate of proficiency, which will show that they have profited by the instruction given to them, and in the event of their failing to qualify in this respect their appointments will not be confirmed, and they will be required to refund

any payments made on account of their expenses. Similarly, doctors already in the Colonial service, who attend courses, will be required to refund the fees unless they are certified to have made good use of their time and opportunities at the School.

17. Between the 2nd October, 1899, and the 15th April, 1903, that is to say, during a period of about three years and a half, 292 students passed through the London School, viz. :—

British Government Service :—	
Colonial Office	116
Foreign Office...	13
Indian Medical Staff	11
Royal Army Medical Corps	1
Royal Navy	3
	144
British private students, missionaries, &c.	113
Foreign Government Service...	13
Foreign private students	22
	292

I am informed that the average attendance at lectures and demonstrations has been over 90 per cent. of the total number of students at the School.

The appliances in the School are well up to date, and the constant presence of a medical superintendent and tutor ensures that all special diseases are demonstrated and investigated as opportunity arises.

I am informed by the Committee of Management that up to the present time the School has just paid its way on the receipts from tuition and from board and lodging fees. Thus, for the period from the 2nd October, 1899 (when the School was first opened) to the 31st of December, 1899, there was a deficit of £14 17*s.*, for the year 1900 there was a surplus of £78 9*s.*, for the year 1901 there was a small deficit of 13*s.* 4*d.*, and for the year 1902 there was a surplus of £108 5*s.* 5*d.*

18. Owing, however, to the success of the School the Managers consider that it is now necessary to place matters on a wider basis. The present buildings are too small, whether from a tutorial or from a research point of view. There is only proper accommodation for sixteen students in the laboratory, while the average attendance of students is 24. Research laboratories, a lecture theatre, and museum, are said to be much needed, and the library requires enlargement. The residential accommodation should also be increased. At present there is only accommodation for six resident students, the number contemplated when the scheme was first set on foot, whereas it is considered that there should be sufficient accommodation for at least 20. Up to November last the Managers had expended a sum amounting to £16,098 on the enlargement of the hospital, and one of £6,676 on school buildings, furniture, and equipment, £3,550 out of this last sum having been, as already stated, contributed by the Imperial and Colonial Governments, in addition to £1,000 given by the Government of India. A sum of £12,000 is now stated to be required to cover the cost of the new buildings, and to meet this expenditure a sum of no more than £3,000 is at present available.

19. It will be seen from the above that the School has carried out a great deal of teaching work. Much of the work has been done by lecturers who have received only a nominal remuneration, and the Committee of Management consider—and, I think, rightly consider—that in order to place matters on a sound basis, the lectureships should be permanently endowed. An additional sum of money will be required for this purpose as well as for the extension of the research work of the school to which I shall refer hereafter.

20. The Governments of Ceylon, the Straits Settlements, the Federated Malay States, and Hong Kong have each promised a subsidy of £100 per annum for five years towards the revenue of the school, and some munificent private donations have been received ; but these contributions are, I am assured, insufficient to meet the growing requirements, and the Committee of Management are endeavouring to raise a large capital

sum for the various objects referred to above. Whatever may be the result of their fresh efforts, it may safely be said that the policy which resulted in establishing the school has up to the present time been fully justified.

21. I will now return to the question of the scientific enquiry into malaria. The experts who were selected for two years' work under the Malaria Committee, were Dr. Daniels of the British Guiana Medical Service, nominated by myself, and Drs. Stephens and Christophers, of Cambridge University and University College, Liverpool, respectively, nominated by the Royal Society. It was decided that they should, in the first instance, at any rate, carry out their investigations in the British Central Africa Protectorate, from Blantyre as a centre: Blantyre having been suggested, as a comparatively healthy place on the edge of the malarious zone, and as possessing facilities for the desired investigation, such as a hospital and hospital appliances.

Before starting for Central Africa early in December, 1898, Drs. Stephens and Christophers paid a short preliminary visit to Italy; they reached Blantyre about the beginning of February, 1899. Dr. Daniels, being seconded from British Guiana, proceeded to India in November, 1898, and studied for between two and three months under Major Ross, subsequently joining his colleagues at Blantyre on 8th April, 1899.

22. In the meantime it was suggested by the Malaria Committee that, with a view to obtaining exact knowledge of the different species of mosquitoes and allied insects in the various tropical colonies, it would be well if collections of the winged insects in those colonies which bite men or animals could be made and sent to the Natural History Museum, where Professor Ray Lankester undertook to have them examined and classified. A circular despatch to that effect was written to the Crown Colonies on the 6th of December, 1898, a copy of it being sent to the self-governing colonies on the 15th of that month; and on the 8th of September, 1900, a further circular was sent enclosing copies of a preliminary report received from the trustees of the Museum on the collections which had been received. The specimens so collected have enabled the Trustees of the British Museum to publish, under the editorship of Mr. Theobald, a monograph on the Culicidae, the great scientific and practical value of which has been shown by the first edition being almost immediately exhausted.

23. In June, 1899, Drs. Stephens and Christophers telegraphed to the Royal Society, urging that their stay in Central Africa should not be prolonged beyond the following August, owing to the scarcity of cases of the kind required for study, and the insufficiency of the hospital accommodation. They were, after some correspondence, authorised to leave, with a view to proceeding to West Africa. They left British Central Africa accordingly on the 20th of September, 1899; and, after returning to this country, sailed for Sierra Leone on the 9th of December, 1899, subsequently visiting the Gold Coast and Lagos. They returned to this country in November, 1900; and in April, 1901, as it had been decided to prolong the term of their engagement, Dr. Christophers left for India, where Dr. Stephens had already gone, in order to continue the investigation for one more year. Dr. Stephens was obliged through ill-health to return to this country before the year's work was fully completed, but Dr. Christophers' services were retained in India for an additional six months, and his engagement was not concluded until last autumn.

24. Dr. Daniels, having dissented from his colleagues as to the desirability of leaving British Central Africa, which he considered an eminently suitable field for enquiry, was authorized to remain there when they proceeded to West Africa. He continued his work in these districts until July, 1900, when, on account of an attack of blackwater fever he was compelled to return to England. On his return to England his work in connexion with the malaria commission ceased, the two years which had been originally contemplated in the case of the Commission having nearly expired. He took up the position of medical superintendent of the London School of Tropical Medicine, and in August, 1901, sailed for Sierra Leone to join a malarial investigation Commission under Major Ross which had been sent out by the Liverpool School.

25. The enquirers communicated the results of their work to the Malaria Committee in a series of reports which were published by the Royal Society. In the circular despatches noted in the margin printed copies of these reports were sent to the Colonies. A general summary by Drs. Stephens and Christophers of their work written in less technical language than are the reports themselves, together with a covering report upon it by the Malaria Committee forms an enclosure to this despatch.

19 July, 1900.
29 August, 1900.
25January, 1901.
16 May, 1901.
11 April, 1903.

26. While these gentlemen were at work in the investigation of malaria in Africa, it was suggested by Dr. Manson in January, 1900, that, in view of the results which Italian medical experts had already achieved in the way of preventing malaria by the use of mosquito netting, the experiment should be tried of erecting in some notoriously malarious spot in the Roman Campagna a hut specially designed to exclude mosquitoes, and that two observers, sent out from this country, should live in the hut during the night throughout the malarious season, the activity of the malaria-bearing mosquito being mainly confined to the night-time. He asked for a sum of £500 from Government funds to cover the cost of the experiment, excluding the expenses of one of the two observers, who would be sent by the London School of Tropical Medicine. This sum was allowed from the funds at the disposal of the Malaria Committee and was subsequently supplemented by a further sum of £150; a mosquito-proof hut was constructed under Dr. Manson's directions and sent out to Italy in May, 1900; and the two observers, Dr. Sambon and Dr. Low, started in the same month for Rome where they received every assistance from the Italian authorities. They remained at the hut in good health throughout the malarious season, sending periodical reports, and returned at its close, having established beyond dispute that protection against mosquitoes carries with it immunity from malaria. Mosquitoes which were sent to England from the same district during their sojourn, were found to convey malaria to healthy subjects in this country.

27. I have stated that one of the two observers in this instance, viz.: Dr. Low, was sent by the London School of Tropical Medicine, holding a travelling scholarship, which was established by Mr. J. G. Craggs, M.V.O., in connexion with the school for three years from the 1st of January, 1900. Dr. Low subsequently visited the West Indies and Uganda, carrying out research work in connexion with filariasis and sleeping sickness, and making recommendations of practical value as to the sanitary conditions of the places which he visited. I understand that he is held to have conclusively demonstrated that Filaria Nocturna, like the malaria parasite, is conveyed by mosquito bite. This reference to Dr. Low's work is made in order to illustrate the fact that the services of the London School of Tropical Medicine have not been confined to teaching, but have also included research of a valuable kind. Encouraged by these and similar researches, the Committee of management now desire to found two Travelling Scholarships with a salary of £300 a year each, so that investigations can be carried on continuously in more than one direction. I should mention here that a laboratory for the investigation of tropical disease has been established at Kuala Lumpor in the Federated Malay States, and that the Federal Government have provided the necessary funds for the salaries of a Director and two assistants. An arrangement has been made by which the Medical Superintendent and Tutor of the London School and the Director of the laboratory at Kuala Lumpor are to replace each other for certain periods, and there is every reason to hope that this system of interchange will be attended by good results as regards both teaching efficiency and research.

28. Having thus alluded to some of the research work which has been carried out under the guidance of the London School, I now wish to call attention to the work which has been done in this respect by the Liverpool School of Tropical Medicine. The answer to my first circular letter to the principal medical schools of the United Kingdom, which was received from the Dean of the Medical Faculty of the Victoria University, Liverpool, pointed out that there were exceptional facilities in the hospitals of Liverpool for the study of tropical diseases, and stated that arrangements had been made for the delivery of special lectures on this branch of medicine. At the beginning of 1899 I was advised that a Liverpool School of Tropical Diseases was being established in connection with University College and the Royal Southern Hospital in that city, and was asked that, in addition to formally recognising the certificate given by the school, Government should contribute an annual grant towards its maintenance and a lump sum towards a building scheme. It was explained in reply that, as Imperial and Colonial subscriptions had been recently invited for the London School of Tropical Medicine and the Malarial Investigation Commission, it would not be possible at that time to invite further subscriptions for similar objects in Liverpool. I was then pressed to consent that the specified course of training for newly-appointed Colonial medical officers might be given indifferently in either London or Liverpool, thus placing the Liverpool School, as far as Government recognition was concerned, on exactly the same level as the school in London. As already stated, I declined at first to modify the existing scheme, which had been carefully thought out before being approved, preferring to wait until it had

been in actual working for a short time. Subsequently, in July, 1900, assured of the excellent work which had been done in Liverpool, and of the peculiar advantages which that great seaport offers for the study of tropical diseases, I was glad to make the desired concession.

29. The Liverpool School was opened on the 21st of April, 1899, and at the end of the following July a research expedition, organised in connection with it and headed by Major Ross, was despatched to Sierra Leone. The Committee of the school applied to the Colonial Office for a grant in aid of this and similar expeditions, but the only possible answer was that such funds as were available were required to cover the cost of the Malaria Commission which the Royal Society had helped to organise.

The Governor of Sierra Leone was, however, asked to give Major Ross's party every assistance; and the expedition resulted in identifying the particular species of anopheles mosquito by which malaria is conveyed in that district. This expedition was succeeded by others sent not only to West Africa but also—in connection with yellow fever—to Brazil; an expedition to the Gold Coast, which started in October last, being the eleventh enterprise of the kind, which had been organised by the Liverpool school. Appreciation of the work of the school has been publicly expressed by more than one West African Governor, and its equipment has recently been brought up to date by the opening of a large laboratory specially devoted to the study of Tropical Medicine.

The school has, therefore, amply justified the special recognition which it sought for and obtained from the Government; and, in view of the large amount of money which has been contributed from private sources, I am not surprised that the Committee have asked in a recent appeal, for a "grant from His Majesty's Government of £500 per annum for, say, five years, renewable at the end of that term on inspection and report by officers of the Colonial Department."

30. Before leaving this branch of the subject it may perhaps be useful to summarize in the fewest possible words the more important part of the research work which has been or is being carried out by the schools. A great advance has been made towards the solution of the Malaria problem. In the West Indies, filariasis, and the causes of its prevalence, have been made the subject of enquiry, and simple measures have been suggested by which it might be eradicated. Investigations have been made into the nature, cause, and prevention, of beri-beri, a disease widely spread and responsible for heavy mortality, especially in the Malay Peninsula. In Uganda, some progress has been made in examining the causes and conditions of the deadly sleeping sickness, while in West Africa and Uganda, a new disease (trypanosomiasis) has been discovered and is now being scientifically investigated.

31. At no other place in the United Kingdom, up to the present time, have such opportunities presented themselves for the study of tropical diseases as at London and Liverpool; and it may be open to question whether the multiplication of tropical schools on the same lines as those which have been established at these two centres is to be desired; but this does not imply want of appreciation of the attention which is being given to the subject in the other medical schools of the kingdom. The correspondence which passed, *e.g.*, with Edinburgh University, with King's College, London, and with Queen's College, Belfast, showed the wide interest which was being taken in this branch of medicine and the desire of important medical schools that their efforts in this direction should be duly recognised by the Government. Lately I have been glad to learn that the Special Board of Medicine of Cambridge University have proposed to institute a Special Examination in Tropical Hygiene and Medicine, open to all duly qualified medical practitioners, with a view to granting a diploma in these subjects.

32. The results of what has been done must still be mainly in the future, and it would be matter for satisfaction if no more had been achieved than to stimulate active enquiry and to give additional and special knowledge to a certain number of young medical men destined for the Colonies; but, as a matter of fact, some practical steps have already been taken based on the experience which has been gained.

33. My circular despatch of 17th November, 1900, enclosed copies of a short memorandum, drawn up by Sir Michael Foster and approved by Lord Lister in the previous July (both being members of the Malaria Committee), on "Measures to be taken for the prevention of malaria." The recommendations contained in this leaflet were based on

the assurance that "Recent researches have shown that, at least in the vast majority of cases, probably in all cases, the organism is introduced into the blood, and thus the disease contracted, by the bite of a mosquito, generally, if not always, one species or other of the genus known as anopheles," and practical suggestions were made for the prevention of mosquito bites, *e.g.*, by the use of thin meshed gauzes for dwelling houses; by avoiding sleeping or living near native huts or other haunts of malaria-infected anopheles; and by taking measures directed towards the extirpation of these insects, such as filling up pools and puddles which are their common breeding places.

34. On the following 20th April, 1901, I addressed another circular despatch to the Colonies embodying the recommendations of a Committee appointed to consider "what practical suggestions, if any, could be made to the Governors and Administrators of the different tropical Colonies and Dependencies with a view to diminishing the risk from malaria to health and life, more especially in the case of Government officials."

35. The appointment of this Committee was due to a letter from Dr. Manson to the Colonial Office, dated 24th September, 1900, in which he wrote that "the experiments based on the mosquito malaria theory, which have been instituted by representatives of the Colonial Office and the London School of Tropical Medicine, have reached such a stage and have proved so successful that I venture to submit that the time has come for energetic practical action based on this theory." He made various suggestions, in which Lord Lister and Sir M. Foster expressed general concurrence, one being that a small Committee of experienced Colonial Officials then in England should be constituted to frame regulations on the lines which he sketched out. Accordingly such a Committee was formed, under Lord Onslow's chairmanship, and their recommendations, as embodied in my circular, referred to such matters as choice of sites for buildings, use of wire gauze and mosquito nets, and giving publicity to a large poster with diagrams on "Malaria, its cause and prevention," which Dr. Manson was good enough to prepare, and copies of which formed an enclosure to the despatch. I abstained from offering any opinion myself on the suggestions, not having the requisite professional or local knowledge; but I invited expressions of their views from the various Governors, and have of course left them to use their discretion, with the guidance of the medical men on the spot, as to what exact steps might be taken and how far the results of the recent experiments could be usefully adopted.

36. In West Africa, to which I may more specially refer, strong efforts have been made under the guidance of the Liverpool expeditions to extirpate the malaria-bearing mosquitoes in townships, as at Bathurst in the Gambia and Freetown in Sierra Leone. These operations have entailed a considerable expenditure upon the Liverpool School of Tropical Medicine, and also upon the local Governments, who are now incurring still further expense in carrying on the work already begun.

The Sierra Leone Government is also incurring expenditure amounting to upwards of £30,000 in the construction of a railway to the hills in the neighbourhood of Freetown, with the special object of providing healthy sites on higher ground, removed from the centre of native population.

On the Gold Coast a definite scheme of sanitary organisation and improvement has been drawn up for Cape Coast, the most unhealthy town of the colony, on the basis of a report by Dr. Logan Taylor, of the Liverpool School, and is being carried into effect as opportunity offers. The town of Secondee has been laid out by the Government on modern lines, the European quarter being kept distinct from the native, with a view to diminishing the risk of infection from Malaria. Tanks under Government control have been made mosquito-proof, wells have been covered, and all pools which form the breeding places of mosquitoes are being filled in, as far as practicable.

In Lagos Sir W. MacGregor has taken active and personal interest in the problem of combating malaria, and has adopted such practical measures for reducing the unhealthiness of the Colony as filling up swamps and pools on the island, and on the mainland in the neighbourhood of the railway, providing mosquito-proof houses, purifying wells and supplying rainwater tanks, spreading knowledge of elementary hygiene among the natives by means of lectures delivered by medical officers, and establishing dispensaries and out-stations for the distribution of quinine.

In Southern Nigeria steps have been taken, with considerable success, to improve the sanitation of Akassa, in accordance with the suggestions made by Dr. Annett, of the Liverpool School. A scheme has also been recently initiated for establishing

European reservations at the larger stations, the cost of sanitary improvement being met partly by Government and partly by rates paid by the inhabitants.

In Northern Nigeria the work of occupation and settlement has not given much opportunity for carrying out sanitation to any large extent, except at Lokoja.

37. I have not yet referred to the question of providing trained private nurses for the Crown Colonies. Soon after I became Secretary of State this question came before me, and on the 26th and 27th of June, 1896, I addressed two circular despatches to the Colonies, one enclosing certain recommendations made by a Committee of Medical Officers connected with the Colonies, who, under the chairmanship of Sir Charles Gage-Brown, were good enough, at my request, to consider the question; the other forwarding and commending the scheme of the then newly-formed Colonial Nursing Association. The Association have received a grant of £500 from the Government of the Federated Malay States, and are paid a fee of £2 2*s*. for each nurse selected by them for the Government service of the West African Colonies and Protectorates, but I am not aware that they receive any other support from the Colonial Governments. I attach very great importance to this subject of nursing, and more especially to the training of native women under the supervision of nurses sent out from this country. I, therefore, cordially recognise the value of the work done by the Colonial Nursing Association.

38. The above is an outline of what has been attempted in the direction of improving health and sanitation in the tropical Colonies and Protectorates, and the Governments concerned will, I think, realise that the contributions which they have given have been applied to objects second to none in importance and public usefulness. But it is clear that the work cannot stand still, and as long as those who can speak with the authority of science are confident that by human effort the rate of mortality from malaria and other tropical diseases can be greatly reduced and the strength and efficiency of European residents in unhealthy climates can be sensibly increased, so long, in my opinion, ought funds to be forthcoming for carrying on what has been so well begun. It will be seen from the important letter from Sir M. Foster, of which I enclose a copy, that in his opinion greater expenditure and more extended effort is required to grapple with the whole problem of exotic diseases among not only human beings, but animals also, and to systematise the knowledge of such discoveries as may be achieved. The details of such a scheme would require very careful consideration, but in any case the Colonies are likely to be vitally concerned for many years to come with the following objects: research into malaria and other tropical diseases, in which I am assured that the Royal Society, to whom my warm acknowledgments are due, will continue to co-operate; the Schools of Tropical Medicine, pre-eminently those of London and Liverpool; and the supply of trained nurses. One or other of these objects may more specially commend itself to this or that Colony, but I am inclined to think that as a fund was successfully formed for the double object of the London Tropical School and the Malaria Commission, so Colonial contributions, if and when made, might with advantage continue to be paid into a common fund, out of which the objects which have formed the subject of this despatch might be subsidised. Should I find that this opinion is shared and that there is a general desire on the part of the Crown Colonies and Protectorates to give moderate donations or subscriptions in aid of medical and sanitary training and research, I should propose to appoint a Board to advise the Secretary of State as to how the moneys received can at any given time be best allotted, such Board to consist of the medical adviser of the Colonial Office, a representative of the Royal Society, some leading London physician, one or more representatives of the Crown Colonies, and one or more members of the Colonial Office.

Sir M. Foster, May 2, 1903.

I have the honour to be,
Sir,
Your most obedient humble servant,

J. CHAMBERLAIN.

The Officer Administering
the Government of .

Enclosure No. 1.

STATEMENT OF RECEIPTS AND EXPENDITURE OF THE MALARIAL FEVER COMMISSION ACCOUNT.

Receipts.

	£	s.	d.
Southern Nigeria	1,050	0	0
Gold Coast	1,050	0	0
Lagos	1,000	0	0
Trinidad	700	0	0
Hong Kong...	500	0	0
British Guiana	500	0	0
Gambia	200	0	0
Straits Settlements... ...	489	11	8
Sierra Leone	300	0	0
Ceylon	1,000	0	0
Federated Malay States ...	494	15	10
Mauritius	250	0	0
Jamaica	250	0	0
Fiji	100	0	0
St. Lucia	100	0	0
British Honduras	50	0	0
Royal Society	600	0	0
Interest on Advances ...	303	10	10
	8,937	18	4

Expenditure.

	£	s.	d.
Preliminary...	30	19	6
Books, Appliances, &c. ...	395	3	1
Salaries and Allowances ...	5,242	7	1
Passages	549	0	10
Freight and Charges ...	35	7	10
School of Tropical Medicine	1,775	0	0
Expenses in connection with Mosquito-Proof Hut, &c.	307	16	7
Iron Building	219	14	11
Expenses in connection with Report	185	18	2
Translating...	10	10	0
	8,751	18	0
Balance in hand to 31st March, 1903 ...	186	0	4
	8,937	18	4

Details of Balance.—

	£	s.	d.
Cash lent at Interest	185	0	0
Cash in hand ...	1	0	4
	186	0	4

Dr. Christophers has drawn Salary to 7 June, 1902.

Dr. Stephens has drawn Salary to 28 March, 1902.

Enclosure No. 2.

ROYAL SOCIETY to COLONIAL OFFICE.

(Received April 24, 1903.)

SIR, Burlington House, London, W., April 24, 1903.

I HAVE the honour to inform you that the last Report of the Malaria Commission has now been passed for press; hence, the actual investigations having been completed some time back, the labours of the Commission may be considered at an end. I take the opportunity to pass in brief review, on behalf of the Malaria Committee, what has been accomplished by the Commission. And I enclose a memorandum by Drs. Stephens and Christophers, in which these observers expound their own views as to the result of their researches, more especially in respect to native malaria, the prevention of malaria, and the nature of blackwater fever.

At the time when the Commission, consisting of Drs. Daniels, Stephens and Christophers, was appointed, the manner in which the malaria parasites are communicated to man by the mosquito had been clearly indicated by the researches of Ross. But as the evidence in favour of his view rested as yet simply upon his individual testimony, it seemed desirable that his observations should be subjected

to independent criticism. This part was undertaken by Dr. Daniels, who, in 1898, proceeded to India for that purpose. He repeated Ross's experiments under his directions, and confirmed in every particular his facts and conclusions. Meanwhile, the other two members of the Commission were engaged in researches in British Central Africa where, for reasons which need not be detailed here, it was decided that they should begin their investigations. Daniels joined them after completing his mission to Ross, but he worked for the most part independently. Valuable observations were made by all the members of the Commission, but, partly for the reason that the opportunities for making observations were not so great as had been anticipated, their labours in British Central Africa, though extending our knowledge in several respects, cannot be said to have produced any very striking results. The investigations conducted there were chiefly of an introductory and preparatory character. Returning to England in 1899, Drs. Stephens and Christophers, now fully acquainted with all the recent results obtained in India by Major Ross and in Italy by various observers, proceeded in the same year to the West Coast of Africa. Here their researches confirmed and extended our previous knowledge, and their studies on the distribution and natural history of the several species of Anopheles, and other mosquitos met with there, were of great value.

They further made the most important discovery (made independently about the same time by Koch) that while the native adult in such regions is in great measure immune towards malaria, the disease is exceedingly prevalent among native children. They showed, indeed, that this was so much the case that in these regions the native is a prime agent in the infection of Europeans with malaria, and that the segregation of the white man from the native, and the avoidance of native huts, which are nests of infected Anopheles, form a potent means for the prevention of the disease. The importance of this discovery from a prophylactic point of view is of the first order.

After completing their researches on the West Coast of Africa at Lagos and Sierra Leone, Drs. Stephens and Christophers proceeded in 1901 to India, carrying out their researches first in Bengal and subsequently in the Punjaub.

They have carefully investigated in various districts the species of Anopheles carrying the malaria parasite and acting as agents of infection, a knowledge of which is the necessary antecedent to prophylactic measures.

They find as in West Africa, though perhaps to a less extent, that the native children contain parasites in their blood and must, therefore, be regarded as sources of infection. They maintain, indeed, that in any district the percentage of native children infected with the parasite may be taken as the index of the prevalence of malaria in the district, or as they term it, of malarial endemicity; and they have determined the connection of this index with the presence or nearness of the breeding places of the species of Anopheles serving as carriers of infection. This knowledge is of direct service from a prophylactic point of view.

They point out, however, that in certain cases abundance of a species capable, if themselves infected, of infecting man, may exist with a very low malarial endemic index; this points to certain unknown factors in the spread of the disease, the discovery of which may be of great practical value.

Their study of the malaria at Mian Mir led them to begin an interesting experiment on a method of exterminating the infecting Anopheles by treatment of the irrigation canals. This experiment, in order to be demonstrative, needed to be carried on for a considerable time, and, since the departure of Drs. Stephens and Christophers, has been carried on by Captain James.

At the outset, the Commission was instructed to study, not only ordinary malaria in its various forms, but also and especially the disease known as "Blackwater Fever," the relations of which to malaria had been a matter of dispute, some observers maintaining that it was a form of malaria, others that it has no necessary connection with that disease, or is at any rate due to a special strain of parasite.

Drs. Stephens and Christophers began their study of Blackwater Fever in British Central Africa and continued to investigate it in the West Coast of Africa and in India. Their observations have led them to the conclusion that the disease is essentially of malarial origin and not due to a different parasite. Though, with the onset of an attack the malarial organisms disappear from the blood, they leave

distinctive traces of themselves in certain features of the blood corpuscles; and the occurrence of Blackwater Fever is coincident with high malarial endemicity, *i.e.*, with the large occurrence of the malarial parasite in the blood of native children.

Hence, and this is a matter of considerable importance, the prophylaxis of Blackwater Fever is in the main identical with that of malaria; that is, the prevention of malarial infection by mosquito bite or, if the infection has taken place, the adoption of remedial measures including the adequate and proper use of quinine; with respect to the latter, it should be added that an attack of the disease may be brought on by the injudicious use of quinine when the patient is in a condition of malarial cachexia. It may be hoped that with the adoption of general measures against malaria and care in the use of quinine this dreaded scourge may be largely done away with.

I venture to hope, Sir, that His Majesty's Government and the Colonies will feel able to share the opinion of the Royal Society that the money and labour which have been spent on this enquiry have been well repaid. The investigations of the Commission have undoubtedly contributed largely to that remarkable increase of our knowledge of the nature and causes of malaria which has been gained during the past few years—a knowledge which promises, if not to exterminate, at least so to diminish the occurrence of that disease as to permit the white man to live in health, strength, and comfort in regions which previously had been dreaded, and justly dreaded, as places of almost certain sickness and of not improbable death.

I may add that malaria is not the only disease which offers obstacles to the prosperity of the Empire in tropical countries. There are other diseases affecting men, and also diseases affecting animals such as cattle in these tropical and sub-tropical countries, the occurrence of which forms an obstacle, and at times brings disaster to colonial enterprise. May I suggest that the plan of operations which has been so fruitful in respect to malaria, might with advantage be repeated in view of other maladies of man and animals, and that a permanent organisation for the study of the nature and causes of these maladies, a knowledge of which can alone form a sound basis of operations for prevention, might fairly be expected to furnish an adequate return for money spent upon it.

Thanks to the institution of schools of tropical medicine in London and in Liverpool, and to the increased interest in these diseases which has developed throughout the country, it will not be difficult to find young men of talent adequately trained for the investigation of these diseases, and prepared by their love of science and enquiry, to undergo such hardships, or to face such dangers, as may accompany these investigations.

I have, &c.,
M. FOSTER,
Secretary, Royal Society.

Sub-Enclosure in Enclosure No. 2.

SUMMARY OF RESEARCHES ON NATIVE MALARIA AND MALARIAL PROPHYLAXIS; ON BLACKWATER FEVER: ITS NATURE AND PROPHYLAXIS.

By J. W. W. STEPHENS, M.D. Cantab, D.P.H., Lecturer in Tropical Medicine, Liverpool, and S. R. CHRISTOPHERS, M.B., Vict., I.M.S.

I.

Of our researches on malaria those relating to native malaria seem to us of such great practical importance that in the present report we have almost entirely confined ourselves to a discussion of these, and their application to the prevention of malaria among Europeans in the tropics.

It is unnecessary here to discuss the question of the mosquito transmission of malaria. We may, however, lay stress on some points which are as yet often overlooked:

1. It is practically certain that the mosquito cycle is the only one. We cannot, in the space at our disposal, give all the reasons for this statement; suffice

it to say that up to the present no competent observer has brought forward a single fact inexplicable by mosquito transmission or suggesting any other channel of infection.

2. Regarding other hosts of the malarial parasite than man, no one has found any other animal than man infected with the organism of human malaria. The supposition that monkeys may be the means of infecting anopheles in the jungle is made highly improbable by Koch's researches. We may point out, too, that such a supposition is in no way needed to explain malaria contracted in the jungle, the real mode of infection in such conditions being now quite well understood.

3. All recent research confirms the view that malaria is always derived from malaria pre-existing in others. It is as important to recognise that *malaria is only derived from man* as it is to appreciate that it is only transmitted by the mosquito (Anopheles). In other words malaria is as much an infectious disease as scarlet fever, the only difference being that it is not conveyed by contact, but only by the Anopheles mosquito.

Malaria then is an infectious disease—the infection or malaria parasite being conveyed from one person to another by the bite of Anopheles. An Anopheles mosquito, *per se*, is harmless; it is only an Anopheles containing parasites, or in other words an infected Anopheles, that can transmit malaria, and the only way by which an Anopheles can become infected is by "biting" some person who has the parasite in his or her blood.

It at first sight seems strange that the infective character of malaria has been and is still so overlooked by the general public. The actual mode of infection, however, has lately been made clear. Malaria is not in the tropics usually contracted from "fever" cases, but almost always from "latent" malaria in the native population.

Native Malaria.

1. Koch, in the East Indies, almost everywhere found malaria in the children though adults were free from infection. He commonly found malarial infection only on microscopical examination of the blood. In some of the villages examined by him every child had malaria, in others a smaller proportion. He came to the conclusion that the degree of infection he found in these children was a test of the intensity of malaria.

2. We ourselves, finding that Anopheles caught in native villages always contained a considerable percentage of infected specimens, were led to the discovery that this was dependent upon a general infection of the native children of Africa who, although apparently in good health, had almost always the malarial parasite in their blood. We were thus able to show that the home of malaria is in native huts, hamlets, villages, and towns, and that European malaria is a mere resulting sign of the vast degree of indigenous latent malaria.

This has been amply confirmed subsequently by other observers, notably by Annett and Dutton in Nigeria, Ziemann in the Cameroons, and again by ourselves in India.

The infection of Anopheles.

Where human infection is so general we should expect also to find Anopheles infected, and, indeed, in any batch of Anopheles caught in native huts a greater or less proportion always contain sporozoits, *i.e.*, the malarial parasite in a condition ready for infecting man. The number of Anopheles infected is a variable one. As a rule in Africa it is from 5 per cent. to 10 per cent., but reached in some villages 50 per cent. Aro, on the Lagos railway, was an instance where the sporozoit rate in Anopheles caught in native huts was 50 per cent. Obviously it would be as difficult to avoid malaria in such a place as small-pox in a small-pox hospital.

We have said before that Anopheles are only capable of giving rise to malaria when they have previously fed upon blood containing malarial parasites, but a curious fact, and one of great importance, may be here noted. Anopheles are mainly to be found in association with native dwellings. One has not long to do with Anopheles

without finding that they are hardly ever really abundant, except in native communities. Whenever in any place we wished to collect large numbers, our invariable practice was to proceed to the native quarter, and there we could collect Anopheles generally without difficulty. It was otherwise elsewhere, and in remote marshes occasional specimens (most frequently of a "wild" species) only were caught in our tents. So far as appears at present, the majority of Anopheles in Africa haunt native villages. It is, perhaps, almost permissible to say that about 5 per cent. of all the Anopheles of tropical Africa are infected with malaria and infected solely because they have derived the infection from latent native malaria.

In nearly every hut, then, of the millions scattered over the jungle lands of Africa, and of those forming the densely crowded towns of West Africa, we have children with parasites in their blood, and Anopheles to disseminate these.

The consequent infection of Europeans.

The condition of extreme unhealthiness found *par excellence*, in West Africa is not determined by the "climate." The reason is largely to be found in the conditions under which Europeans at present live in Africa. Even on general grounds it would be well to avoid native huts and hovels, with all their dirt and insanitary surroundings, conditions which may be likened to those in the worst slums of our large towns. When, however, we realise that these huts are veritable hotbeds of malaria, it is evident that the very first sanitary law for Europeans in Africa is to avoid their neighbourhood. It is, however, a striking, but most deplorable, feature that in Africa hardly ever do we find a European bungalow or dwelling place built with this end in view. European houses are often situated among the huts of the natives in towns, as in Freetown, Sierra Leone, or they have a cluster of hovels or huts close at hand. In one instance we saw a new settlement being built on the very fringe of a native village. It was not a question of necessity, as land free from villages or huts was available all around, nor was there any reason of policy, the Europeans being employed on the railway, and having no relation with the villagers. The choice of such a site sufficient in itself to ensure the settlement being a very deadly one, as it indeed was later the case, could only be deplored. To sum up, then, we can say that with certain notable exceptions, to be mentioned later, the European on the West Coast of Africa is living in the midst of native huts and is consequently daily exposed to the bites of infected Anopheles. The actual conditions are described in greater detail in the following section dealing with prophylaxis.

Prophylaxis.

At the outset we shall divide the prophylaxis of malaria under two heads:—

1. The prevention of malaria in native communities.
2. The prevention of malaria in Europeans.

The two problems are essentially different, and no confusion should ever exist in our minds as to what any given anti-malarial measures are intended to achieve, whether increased health of resident Europeans or diminution of native malaria.

1. *The prevention of malaria in native communities.*

Prophylactic measures applicable to the average native of tropical Africa are, for many years to come, beyond discussion. The vast bulk of African natives are completely beyond any sanitary control whatever. In some large towns a measure of control does exist, *e.g.*, Freetown, Lagos, Accra, Cape Coast Castle and a few others. In these only has one the least hope of achieving any result.

Methods of malarial prevention applicable to large native communities seem confined to some form of Anopheles destruction, either by superficial drainage or by the continuous labours of a mosquito brigade. The administration of quinine, advocated by Koch, though so effective under the conditions at Stephansort, could not, we feel certain, be applied with any measure of success even in Freetown or Lagos. Speaking briefly we, ourselves, do not believe that with the means at the disposal of the sanitary bodies in West Africa any appreciable diminution in native malaria can at

present be brought about. The destruction of Anopheles larvæ was, at first sight, so effective a means of getting rid of malaria that schemes for extensive destruction had many advocates. In our own experience the outlook has become less hopeful the more the habits of Anopheles have become known, and our opinion of the practicability of such operations has become gradually subverted by the practical experience of the difficulty of undertaking effective measures on a large scale. If drainage can be efficiently carried out over a particular area, it would, we believe, be successful in diminishing native malaria, but the conditions surrounding each case must determine to what extent such measures can be applied.

2. *The prevention of malaria in Europeans.*

In 1900, working on the Gold Coast, we advocated the protection of Europeans in Africa as being at present the proper and legitimate object of our limited resources in Africa. We gave reasons for believing that a system of segregation from the native, carried out as opportunity offered, would be far more effective than any other prophylactic measure within our power. We have already seen that the malarial fever to which the European is subject is due to the fact that he lives amidst the natives, or with the native at his door. We would emphasize again the fact that these conditions have impressed themselves upon us so vividly, because our experience of them has not been that of a passing observation, but one derived from actually living under them. We have enjoyed the hospitality of very many Europeans, and have slept in the bungalows and quarters of officials, railway engineers, missionaries, settlers, traders, in quarters in the centre of native camps, always with the inevitable native huts in the compound, and in all, these conditions held good. Realising the danger of sleeping under such conditions we succeeded in preserving our health only by most constant and unremitting care in the use of personal precautions. Such precautions we, however, found were generally so irksome that men preferred to run the risk of infection rather than bestow the necessary attention to them. Although we used mosquito nets we found it necessary to employ an extraordinary and troublesome degree of care in their use in such conditions as are usual in African up-country stations, and we believe but few men would employ them with sufficient care to avoid infection in such places. Similarly with regard to houses protected with wire gauze. Even where the oppressiveness of the climate would not preclude their use, we consider that it is only by a constant vigilance that but few men would exercise, that such measures could be successful.

As a preliminary step to all other prophylactic measures, and as one likely more than any other to minimise European malaria we, therefore, advocate "Segregation from the Native."

Since we first put forward segregation as a principle to be followed whenever opportunity offered, it has been recognised by some authorities* as the first law of hygiene in the tropics; on the other hand it has met with criticism. Much of the latter is evidently based on mistaken notions of what is meant by segregation, and what segregation entails. Segregation as an anti-malarial measure does not, for instance, mean the avoidance of intercourse with the native. Nor does it mean a lessening of the power of control of the native. It has been said that segregation means giving up a country. Such a notion could only arise from a complete misconception of what is meant by segregation in this connection. The fact that in India segregation is almost universal seems to us to effectively meet such objections. In India we do not, except rarely, find European dwellings and native quarters crowded together, but almost always a well-designed European quarter, quite distinct from the native bazaar. Yet in India there can be no question of loss of touch with the natives—rather on the contrary, an increased respect on their part.

To talk also of the impossibility or impracticability of segregation in Africa is absurd, because a most excellently carried out scheme of segregation already exists at Accra (Victoriaborg), and to a less extent at Old Calabar, both which places are noted on the West Coast for their comparative healthiness. Moreover, since we first advocated such measures they have been advocated also by Annett and Dutton (2nd Liverpool Expedition) as applicable, above any others, to Nigeria. These authors had

* NOTE.—Manson. Practitioner, 1900. Annett and Dutton, 2nd Expedition Liverpool School.

actual experience, during many months, of the condition under which the European lives, and they advocate segregation as strongly as we do ourselves.

Further, Logan Taylor, himself engaged in destructive measures against mosquitoes, says* "When suitable ground can be had I think it better for the European to live away from the native town. In Accra the Government officials have good bungalows away from the native town, forming a proper European quarter (Victoriaborg), and this arrangement is found to work well, and Accra is the healthiest town on the Gold Coast."†

Practical Application of Segregation to Various Conditions of Life in Tropical Africa.

Since we feel very strongly that the segregation of Europeans is the first step in the prophylaxis of malaria in Africa and other tropical regions, we think it desirable to show how in practically every condition of life this principle can be applied.

So far prophylaxis (destructive measures) has been directed entirely against the malaria of large towns. If even, however, we could make the large towns of West Africa healthy we should still have an enormous fever and death rate among Europeans on the Coast, quite half of whom live in out-stations, and the great majority of whom make very frequent tours. Moreover, it is in *out-stations* that Europeans are chiefly in need of protection. Whereas we found that residents in towns enjoyed, on the whole, fair health, it was in out-stations that we chiefly found men in the fever-stricken and miserable condition so characteristic of tropical Africa. We would point out then that something more than anti-malarial measures in large towns is needed if much improvement in the health of Europeans is to result.

It is here that "segregation" holds out such prospects of success. Not only is the formation of a European quarter in large towns a fundamental law of health, but, as we shall show, in out-stations, railway camps, mission stations, in bungalows, in tea or coffee gardens, in expeditions, military or otherwise, in ordinary travelling, segregation is equally applicable.

Before malaria is made to decrease among Europeans in Africa it must be generally recognised that malaria is an infectious disease, and that it is present in practically every native hut. When this is the case men will refuse to allow in their compounds squalid grass and palm leaf huts; they will cease to build their bungalows among or on the outskirts of villages; they will be extremely careful where they sleep when travelling, and it will be the duty of the medical officers of mining camps, railways, and military expeditions to absolutely forbid the forming of any camps near native huts, or to allow these to spring up in the more permanent camps.

1. *Segregation in large towns.*

We have two noteworthy instances where in large towns segregation has been carried out most effectively, with the result that the two segregated communities, Accra (Victoriaborg), and Old Calabar, are notoriously the most healthy on the coast.

Moreover, in any large town where such complete segregation on a large scale is not immediately applicable the principle should be borne in mind, and as opportunity offers, huts should be removed and European houses built in the open. Thus, at Lagos, a well-designed quarter could, we feel sure, be gradually formed, and would place Lagos in the same category as Accra. At Freetown, we believe arrangements are now being made to remove the official quarters to a segregated site on the hills,‡ and at Cape Coast Castle also a site for officials has been chosen, well removed from the

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* Note.—Second Progress Report of the Campaign against Mosquitoes in Sierra Leone. Liverpool University Press.

† Note.—That segregation is a practical measure there is increasing evidence to shew. Thus at Akassa (Nigeria) "a hotbed of fever and disease," segregation has been effected (together with drainage and the regular administration of quinine to Europeans), and Akassa is now one of the healthiest stations in West Africa. (Brit. Med. Jour., April 18, 1903, p. 924.) Further segregation schemes have been carried out at Secondee and Cape Coast Castle.

‡ Note.—Proposed site for European residences in the Sierra Leone hills. Stephens and Christophers. 5th Report to Malaria Committee Royal Society.

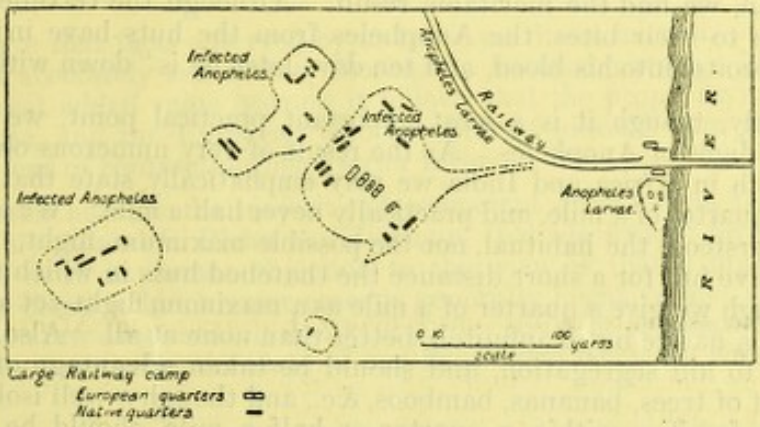
native town. The plan then to be followed in towns is the formation of a European quarter as distant as possible from native huts, and no better examples of this can be found than the arrangement in India of a European Cantonment and native bazaar.

2. *Segregation in out-stations.*

The terrible sickness and mortality resulting from the practice of the European living amidst native huts was nowhere more forcibly brought to our notice than in the camps of engineers and other employés engaged on railways under construction. Every settlement and every camp showed the same most deadly practice of allowing numerous native huts to be erected actually in the compound, in which dwelt camp followers and their numerous families (children). To this fact alone is due the excessive sickness from malaria, and as a consequence also blackwater fever, on railways under construction. The working in swamps, and the turning up of soil are in no way responsible, and a single instance will suffice to show to what railway engineers owe the malaria they so markedly suffer from, for never did we succeed in finding an exception to this deadly arrangement of native huts (with their constant fever supply), and European dwellings close at hand

The Lokomeji Camp on the Lagos Railway: (see plan).

PLAN OF LOKOMEJI.



About half a dozen Europeans lived in this enclosure. In it there were no less than 13 native huts, with, at a guess, 100 inhabitants, men, women, and children.

This is more than enough to explain the constant sickness among Europeans here, but in addition there is a second crowded native compound, and a third within one hundred yards. When we consider that every one of these huts is a source of malaria (for actually one half of the Anopheles caught by us contained parasites in the stage ready for transmission to man), it becomes at once evident that a most unfortunate and disastrous mistake has been made by the Europeans living here. In such a case as this the engineer in charge of the section has the power of selecting a site, and has absolute power to forbid the building of any huts within any distance he chooses. When the European fully understands the certain danger to his health in living under such conditions, he will absolutely refuse to submit to such unnecessary exposure to danger. With ease, on a railway, a well segregated site for Europeans can always be provided. We shall see that a quarter to half a mile is ample, and some protection is ensured often by only a few hundred yards.

We have given a railway camp as an example of the evil effects of living amidst native huts because here, perhaps, most markedly did we see the result in the fever-stricken, anæmic Europeans subject more than any to blackwater fever. The condition of life is, however, equally typical of *all out-stations*, the planter, missionary, trader and even Government officials live universally under similar, though usually less deadly, conditions. In many such out-stations the condition could be remedied by very slight changes, the removal of a few hovels: often a single grass hut has been the source of perpetual fever among the Europeans living in a house.

We do not say that no native servant should sleep in a compound (though personally we found no inconvenience in allowing our servants to sleep away) for it is not in the

presence of one or two adult servants that the danger lies, but in the numerous families (with children) crowded into dark and dirty huts so universally seen at the European's door. Once the fact is recognised that it is from the crowded cooly lines and native quarters that the European derives his fever we feel sure that the whole hygienic aspect of these fever camps will change.

Segregation on Military and other Expeditions and for Travellers and Sportsmen.

The facts already put forward explain also why military expeditions in Africa are attended with such a large amount of sickness and so terrible a mortality. As an example of the mode of contracting malaria on military expeditions we may instance Prahsu, a well known halting place on the way to Kumasi from the Coast. It is probable that every man passing up or down to the Coast during the Ashanti campaigns slept at least a night at this station. From plans of the condition there, European quarters and native huts in close proximity, it is at once evident that here at least was one of the sources of the sickness and mortality among European troops, and not in the "climate."

In native villages the native porters are able to procure food, and here generally a clearing is found ready for a camp. So that it is the almost invariable practice of travellers of all kinds to camp in the village clearing, often to sleep in the native huts.

Here, again, we find the inevitable result. Although the traveller may not pay much attention to their bites, the Anopheles from the huts have injected malaria parasites (sporozoits) into his blood, and ten days later he is "down with fever."

Here, briefly, though it is a most important practical point, we must consider the question of flight of Anopheles. As the result of very numerous observations and experiments both in Africa and India we may emphatically state that Anopheles do not often fly a quarter of a mile, and practically never half a mile. We are considering, it must be understood, the habitual, not the possible maximum, flight. Anopheles, in fact, tend to leave but for a short distance the thatched huts in which they spend the day, and although we give a quarter of a mile as a maximum flight yet a segregation of 100 yards from a native hut is infinitely better than none at all Also, every natural obstacle tends to aid segregation, and should be taken advantage of, as the ridge of a hill, a belt of trees, bananas, bamboos, &c., and though a well isolated dwelling, with no native families within a quarter or half a mile, should be aimed at, yet when native huts exist which it is impossible to remove, they should be as completely screened as possible by the planting of bananas, &c.

To sum up these various conditions we may say that a European who pitches his camp or builds his permanent quarters half a mile, to take an extreme limit, from any collection of native huts, however small, will avoid infection otherwise almost inevitable, and if in his compound he allows only those servants absolutely necessary, he is in a position to escape the dangers of life in tropical Africa.

Personal Precautions.

We cannot emphasize finally too strongly the need at present for these. We, ourselves, by unremitting care, completely escaped contracting malaria during over three years' residence in Africa and India; in places, too, where, more frequently than not, the deadly conditions we have described existed. Among these precautions we place the proper use of a mosquito net as by far and away the greatest means of individual protection.

1. *Mosquito net.*—The net should be square (not a bell net), should not have a single, even minute, hole, should hang inside the poles if these are used, should be tucked in *under* the mattress, and should *not* trail on the ground. A piece of closely woven material, fastened on all round at the level of the body is a necessary addition, in order to protect the limbs during sleep from bites *through* the net. When not in use the ends of the net should be twisted up somewhat, and then thrown over the top. We always arranged our nets ourselves, never trusting to servants, and further, to be doubly certain, we always carefully searched the interior with a candle before going to sleep. To these minute precautions, solely, we attribute our absolute

freedom from malaria. Employed without care and attention, a mosquito net is little protection in such malarious places as most up-country African stations.

2. *Subsidiary measures.*—In many of the more malarious places we visited we considered that other subsidiary precautions, such as will suggest themselves to any intelligent person, were also necessary. To protect our legs and ankles, for instance, we considered it necessary to wear thick trousers, with puttees, or the very convenient so-called mosquito boots. The face and hands are not in waking hours very likely to be bitten by Anopheles, though they are very likely to be bitten by various species of culex. It must be understood, however, that for precautions to be effective in badly malarious places considerable care and thoughtfulness is entailed, and few followed our example.

3. *Quinine.*—During the whole of our three years' life in the tropics we found it quite unnecessary to use quinine. If, however, the bites of Anopheles cannot be guarded against quinine should be taken as a prophylactic. We consider Professor Koch's method of taking 15 grains on two successive days in each week as the best. Repeated small doses are of doubtful efficacy.

II.—BLACKWATER FEVER.

Considering the fatality of this disease, and the fear it inspires in the European in Africa, we fully realised the importance of trying to solve the vexed question of its cause.

We believe that facts observed by us based on direct microscopical evidence have placed on an absolutely satisfactory footing its malarial nature. The importance of this has a great added value because it follows that the prophylaxis is identical with that of malaria, and the European who can protect himself from attacks of malaria will have no fear of contracting blackwater fever.

It has been held by the majority of competent observers in recent years in the tropics, notably A. and F. Plehn and Ziemann, that blackwater fever was malarial in nature. The most important objection to this view is that a microscopical examination of the blood in blackwater cases is generally negative, *i.e.*, shows no malarial parasites, or so few as to make it doubtful if they could be associated with the attack. This then was practically the state of our knowledge when we commenced our work on this fever.

In our investigations into the ordinary forms of malaria, however, in the tropics, we soon recognised that in severe malaria also an examination of the blood might, in certain cases, reveal no parasites, or in other cases very few, quite insufficient apparently, to account for the severe symptoms. Such cases were those in which quinine had previously been taken, so that it was not an uncommon experience for a blood examination to show, before the taking of quinine, numerous parasites, whereas later, while still high fever and severe symptoms continued, parasites might be entirely absent. Nor was it exclusively in cases where quinine had previously been taken that parasites were absent. In certain cases, though we believe these are comparatively rare, parasites may be absent, or if present, are so few in number that they bear no proportion to the severity of the attack. And, indeed, our experience has been confirmed by others working both in the tropics and in Europe by Celli, Ziemann, Schaudin.* Thus the last named says, in case I., parasites were present during the attack and during the intervals of the fever, but in case II. they were almost always absent on the day after the attack and during the attack they were very scanty, although the fever was extraordinarily severe.

We were led then, in such cases as these, to seek for other proofs of the malarial origin of the fever. Two such methods were adopted by us: the first consisted in a thorough search in extensive blood films for pigmented leucocytes, which are evidence of a recent attack of malaria. The second was by a determination of the relative proportion of the different varieties of leucocytes in the blood. We followed out this line of observation at length and found that in malaria a relative increase of the large mononuclear leucocytes took place, and were led to consider a value as high as 20 per cent. as evidence of an antecedent malarial attack. Similar observations had also

* Arbeiten, a. d. k. Gesundheitsamte, s. 234, Bd. xix.

led Türk, whose work was then unknown to us, to point out the diagnostic value of this increase in the diagnosis of malaria. We have, then, two auxiliary methods in the diagnosis of malaria:—

1. The detection of pigmented leucocytes.
2. The increase in the percentage of the large mononuclear leucocytes.

Applying these subsidiary tests to blackwater fever in which parasites are, as a rule, absent, we were able to show that nearly all of these cases, apparently non-malarial, are, in fact, malarial, presenting pigmented leucocytes and an increase in the large mononuclear leucocytes. In our first series of 16 cases, although only in 3 were parasites found (about 19 per cent.), yet using these subsidiary tests no less than 93.7 per cent. were shown to be malarial.

We thus, as the result of our work, established on a microscopical basis, the proof of what had been previously mainly conjecture.

Blackwater fever, then, is malarial in origin. It cannot, however, be considered as simply a severe form of malarial fever, for there is yet another side to the question.

In 1860 Tomaselli first published a series of cases in which symptoms of blackwater fever followed upon the administration of quinine, not necessarily in large doses, but almost invariably in those who had suffered much from malaria.

A. Plehn and F. Plehn, in the Cameroons, have published most accurate histories of very many cases of blackwater, and with very rare exceptions they always followed upon the administration of quinine.

Koch has so strongly advocated the quinine factor in blackwater that it appeared at first as if he denied its malarial origin, but this is not so, as is quite clear from his later writings. He holds that quinine is the immediate exciting cause, but that a predisposition, determined by many attacks of malaria, is necessary.

Many of those who hesitated to give their assent to these views now acknowledge that there is such a thing as quinine haemoglobinuria occurring in malaria cases. This acknowledgment amounts to a recognition of the quinine origin of blackwater fever, for the two conditions are absolutely indistinguishable. We have ourselves seen cases which were to us clearly of this nature, and our views are summed up by saying that blackwater fever is a disease malarial in origin, and dependent on blood changes occurring after many malarial attacks, and generally, if not always, in relation to an actual attack, but that also it is undoubtedly almost invariably induced by the taking of quinine in this state.

It has been argued that if quinine is the cause of blackwater fever it is a dangerous drug, and should not be used in malaria, but this argument is not a good one. It is as we believe in the malarial chronic that blackwater almost always occurs. We believe that in such a person quinine is dangerous. If, however, quinine is efficiently used as a preventive of malaria no fear need be held of it. It is inadequate quinine treatment, because malaria is thereby not really combated, which is the danger.

While then we consider that the malarial origin of blackwater fever has been established by us on a basis of microscopical evidence, yet we may briefly consider some other aspects of the question, as it will enable us also to answer some of the objections of a purely general character, which have hitherto been raised against its malarial origin.

1. It has been urged that the distribution of blackwater fever and malaria is not the same. Even if this statement were true it must not be forgotten that the distribution of mild malaria and severe malaria is by no means the same. Thus, the mortality from malaria in the few still remaining foci in Northern Europe is in no way comparable to that of the Roman Campagna, nor, again, is the severity of malaria in Northern Italy comparable with that in the South. We cannot, indeed, speak of the distribution of malaria as a whole. If, however, we confine our remarks to regions of intense malaria we believe that the distribution of blackwater fever will be found to tally exceedingly closely with that of malaria. The distribution of blackwater fever is, we believe, considerably wider than is generally supposed. Thus in the Bengal Duars, in India, blackwater was found by us to be as common as in Africa, a fact to which the literature of the distribution of blackwater fever gave us no clue.

Further, in Madras we discovered the existence of blackwater fever, the existence of which was quite unknown, even to medical men in India. We believe, in fact, that there is rather a very close and even exact parallel between the distribution of blackwater fever and severe malaria.

2. An accurate history of blackwater fever cases will always reveal that the patient has suffered more or less constantly from previous attacks of fever, and that for a day or two previous to his attack he has had a more or less markedly high temperature. That this temperature is of malarial origin is shown by microscopical evidence, for,

3. If the blood of a patient about to suffer from blackwater fever is examined by chance before the onset of the disease, and before the taking of quinine, it is almost invariably the case that malarial parasites are easily found. An examination of the same case after the onset of the blackwater is, however, most frequently negative as regards parasites. Thus Panse, in a recent paper (Zeitschrift für Hygiene, s. i. 1903) found parasites without exception in all those cases which he was able to examine immediately before the onset of the haemoglobinuria; and arrives at exactly the same conclusion as ourselves as to the direct dependence of blackwater on malarial infection.

4. That blackwater fever affects residents mainly in their second and third year suggests that it occurs in conditions of chronic malarial infection, and is strongly against a view which has been suggested that blackwater fever is due to a special parasite. Thus Berenger-Féraud* gives the following data, 1st year, 5.4 per cent., 2nd year, 22.5 per cent., 3rd year, 42.5 per cent., 4th year, 20 per cent., 5th year, 4.8 per cent.

5. Again, the fact that in West Africa and other regions where blackwater fever occurs Europeans die not so much of malaria but of blackwater fever, seems to admit only of one conclusion. To give more exact figures it appears that in the German Colonial possessions out of 3,000 cases of malaria there were 8 deaths only from ordinary malaria, but 62 from blackwater fever. However we consider these general points they all clearly point to the malarial origin of blackwater fever, though, as we have said, the real evidence depends upon the microscopical evidence of malaria in blackwater.

Blackwater fever, then, is malarial in its nature, and its prophylaxis is consequently identical with that of malaria.

J. W. W. Stephens, M.D., Cantab.
S. R. Christophers, M.B. Vict., I.M.S.

February 4, 1903.

Enclosure No. 3.

The Secretary to the Royal Society to Colonial Office.

(Received May 4, 1903.)

Sir, The Royal Society, Burlington House, London, W., May 2, 1903.

The valuable results of the efforts made under your initiative towards the prevention of malaria in the Colonies, encourages me to lay before you the following considerations.

In many parts of the Empire, especially in tropical and sub-tropical countries, the development of Imperial interests is often most seriously impeded or even imperilled by the occurrence of diseases. Some of these, like malaria, yellow fever, sleeping sickness, beri-beri and many others attack man himself. Others, such as horse sickness, rinderpest, redwater, tzetze fly disease and many others attack the domestic animals which man uses.

These diseases, for the most part, do not exist in the British Isles, or are not seen there in the form in which they occur in foreign parts. Hence the knowledge

* "La Fièvre Bilieuse Melanurique."

needed to combat them with success must be gained by studies carried on in the foreign regions in which they occur.

Further, these diseases, as experience has shown, present problems of extreme complexity and difficulty, problems which lie beyond the powers of investigation possessed by the ordinary medical practitioner, and, indeed, call for the exercise of the very highest talents and the use of the very best appliances of modern inquiry. To combat successfully any one of these diseases it is not enough to offer assistance to the local medical officer on duty at the spot where the outbreak of disease is taking place, or even to send out such promising young men as may be induced by a small honorarium to undertake the inquiry. Success in the solution of such difficult problems cannot reasonably be expected unless one is prepared to meet such an expenditure as will secure the services of investigators of acknowledged experience and ability, and will provide these with all the means of inquiry which they need; such larger expenditure is the only one which is truly economical.

Influenced by the above considerations, seeing that these diseases affect the welfare not of the Colonies alone, but of parts of the Empire not under your care, not only of the residents in the foreign places where these diseases may rage, but also of the Army and Navy, which may occasionally visit these places, seeing that the matter is one essentially of Imperial importance, I would venture to suggest, for your consideration, the question whether the organisation which you have carried out with such valuable results might not, to the great benefit of the Empire, be expanded into some larger scheme.

It would be out of place for me to enter into any details now. I will content myself with saying that the scheme which I have in my mind, put broadly, comprises the following points:—

(1) The formation of a fund large enough to cover estimated expenditure, the fund being of an Imperial character, shared by more than one Department, and contributed to by various parts of the Empire.

(2) The administration of this fund by an authorised body.

(3) The expenditure of this fund partly and chiefly in inquiries conducted in the localities where the diseases occur, by special investigators sent out for the purpose or otherwise, but also in part in the maintenance of an establishment at home in which inquiries begun in the fields of the diseases could be more conveniently and effectively completed. It might be desirable to have similar establishments in other places besides England.

I have, &c.,
M. Foster,
Secretary, Royal Society.

The Right Honourable
J. Chamberlain.

APPENDICES.

No. 1.

SIR WM. MACGREGOR to COLONIAL OFFICE.

SIR, Florence, Italy, October 22, 1902.

I HAVE the honour to inform you that on the 13th September I left Florence to visit Egypt with Major Ronald Ross, C.B., F.R.S., who was proceeding to that country by the request of the Suez Canal Company to study the question of malarial fever, from which many of the Company's servants suffer. It had been intimated to the authorities of the Company that I wished to accompany Major Ross on this mission, and they most kindly received me with that gentleman, and thus provided me with many special facilities for the deliberate study of malaria in conjunction with the greatest living authority on the subject, an opportunity that cannot but be of much use to me in dealing with the all-important question of sanitation in West Africa. As I am well aware of the deep interest you take in this great work, I have thought it my duty to put before you a short report on what I saw and learned in Egypt. I also wish to add some account of the opportunities I have had of conducting the same study in Italy, which possesses such unique advantages for carrying on the systematic investigation of malaria. To illustrate this it will be sufficient to mention that some two million cases of malarial fever occur there each year; and that in the midst of this vast field for investigation there are many universities and learned societies enthusiastically at work on the material that surround their permanently established laboratories and hospitals.

2. On the 17th September we reached Port Said and were conducted by the Company's officers to the Company's residence there, where Major Ross at once set to work to obtain information.

There is no malarial fever at Port Said. It occurs at Ismailia and at the Waterworks of the Company at Suez, but very rarely at any intermediate station. A fair average of the cases that present themselves in the Company's service would be about 165 a month, on the basis of the last five years. The greatest number of cases may be in any month from September to November inclusive. It is in the great majority of instances of a mild type; but there have been a few cases of death from pernicious malaria. One case of "blackwater fever" was seen by Dr. Pressart last year.

Malarial fever appeared at Ismailia for the first time in 1877. It seems that a fresh-water canal was dug in 1865 to bring water from the Nile to Ismailia, not far from which a branch is given off to supply Port Said, while a second goes to Suez. The canal was enlarged in 1877, and the appearance of malaria is associated with this enlargement. Naturally it was assumed that the turning up of the soil was the direct cause of the fever then, and up to the discoveries of Major Ross, one of the favourite hypotheses of the origin of malaria. It is easily conceivable that the enlargement of the canal made the introduction of infested mosquitoes easy by vessels navigating the canal from Upper Egypt.

At Port Said the water has added to it forty-six grains of permanganate of potash to the ton. It is then filtered and is distributed by reticulation to the town. This supply is conducted by the Suez Canal Company at Port Said. The Company similarly supplies Suez. There is no filtration at Ismailia. There the Europeans filter the water required for domestic use through native-made clay pots. The Arabs drink it as it arrives from the Nile, though they use in their houses as water receptacles the clay jars used as filters by the Europeans. The canal water is probably

much less dangerous than might at first be supposed, for the direct rays of the Egyptian sun in the slowly-moving canal water must be a powerful bactericide. At the same time, it is noteworthy that the carcases of dogs, horses, &c., are constantly thrown into the fresh-water canal. The maritime canal water, being supplied from the Red Sea and the Mediterranean, the current flowing sometimes in one direction, sometimes in the other, contains salt in such proportions that mosquitoes cannot breed there. We failed to find any mosquito larvæ in the fresh-water canals. The mosquitoes are bred, as will be shown further on, in pools and marshes formed by filtration from the Nile and from the fresh-water canals.

3. At Port Said, where there is no malarial fever, no anopheles mosquitoes were found. There, however, the culex is present in very considerable numbers. Major Ross showed clearly that they are practically exclusively produced in the sewage receptacles of the houses. The variety that carries yellow fever seems to be common enough everywhere in Egypt, but fortunately they are not infected.

4. In proceeding from Port Said to Ismailia we had an opportunity of seeing a thin long line of young trees that have been planted by the Company to protect the fresh-water canal. Some of these are six or seven years old. I visited these plantations at Ismailia in company with M. Cépek, who is charged with the superintendence of them. The principal tree used is the Casuarina (Filahoe of Seychelles, the she-oak of Australia, the Noko-noko of Polynesia). This thrives well wherever tried, except at one place at Ismailia, where it seems to be drowned in water that is too fresh for it. The Tamaris is also growing well. At Ismailia and at Suez there are avenues of acacias that look healthy, but they are being attacked by a borer. Fig-trees, and a few examples of some others, grow where they are daily irrigated. I strongly advised that they should add the Calophyllum Inophyllum and the Terminalia Catappa, two splendid trees for sandy, salt soil, which I am planting at Lagos. There is good ground for believing that these plantations will soon furnish lines of trees from Port Said to Suez. It is only a question of irrigation, and even that may not be required permanently for the Casuarina and for the two trees I have recommended. In connection with the subject of these plantations, two points struck me as very remarkable—the power of the desert sand to carry water in canals, and the great and very important fact that irrigation can be carried on without any danger of breeding mosquitoes, and thus spreading fever. This is one of the most important lessons I learned in Egypt. Hitherto, guided chiefly by what I had read, I dreaded the introduction or extension of irrigation in West Africa. A careful examination of irrigation at Ismailia, Suez, and Cairo has convinced me that a complete system of irrigation could, without danger, be carried out on the Oshun River, for example, in growing cotton or other crops—a fact that may be of great importance for Lagos. The system adopted at Ismailia is to fill the irrigating trenches for two or three hours a day, then to cut off the water. I carefully examined the water channels, and failed to find a single mosquito larva in them. Of course, the watercourses speedily dry up in Egyptian irrigation, but so they will wherever irrigation is really needed. If irrigation is used at Lagos, it should be on a rational and scientific plan, and be kept under Government inspection. Used in that way there need be no apprehension as to the effect on sanitation.

5. It was soon found that the subject of malaria had been intelligently studied and dealt with at Ismailia by the Company's Medical Officers, Drs. Dampeirou and Pressart. They had found anopheles mosquitoes, and had introduced a *régime* of quinine, both curative and preventive. Dr. Dampeirou had several years ago had some swamps partly filled in and partly drained. The position of these officers will be greatly strengthened by the co-operation and advice of Major Ross, with whom they have carefully studied the whole position. Major Ross speedily found the larvæ of anopheles mosquitoes at Ismailia, near the quarters of a family in which there were cases of fever. And he soon demonstrated the presence of the fever parasite in the blood of those suffering from malarial fever. The first anopheles larvæ were found in a small garden cistern near to a dwelling-house, but much greater numbers were met with in the small swamps near the town.

6. Ismailia is built at the west end of Lake Timsah. It is a creation of the Suez Canal. M. Lesseps expected it to become a great city as the port of Cairo. It contains some six or seven thousand inhabitants, including the headquarters of

the Company. In conformity with the anticipations of M. Lesseps, the quarters of the Company are generally located not far from the edge of the lake, on ground considerably lower than the sand dunes between the town and the desert. This produces two evil effects. The first is, that the breeze from the Nile valley blows on to the better-situated Arab quarter, but shoots over the houses of the Europeans. The second is, that water from the Nile and from the fresh-water canals filters through below the sand of the desert and comes out to the surface in the hollows near the town, forming little swamps there that become excellent breeding-places for mosquitoes of all kinds. The nearest swamp is only two or three hundred yards from some of the quarters of the Company's servants, on the north-west of the town. This swamp is about an acre in extent, and is covered by grass, rushes, and a few small willow trees. A watercourse, five or six feet wide, has been cut through the middle of it, and this contains running water which is full of small fish. No mosquito larvæ were found in this water. There was a number of shallow ditches in the grass on each side of the channel, full of pools and vegetation. In these pools there were large numbers of the larvæ of anopheles and culex. This would be easy to cure by filling in with sand, below which the water would percolate into the central watercourse. But it seemed a pity to destroy an acre of grass where there is so little vegetation. It was therefore decided by Major Ross that the ditches should be cleaned, and that crude petroleum should be applied to them regularly. If that fails, the radical cure of filling up with sand can be had recourse to at any time. The second swamp begins some two hundred yards further from the town. It may cover half a score of acres. The greater portion of it is planted with Casuarina trees, and that is partially drained by open, shallow, ditches that are choked by vegetation. These ditches open directly or indirectly into the central watercourse, which, further down, traverses the one-acre swamp already described. The central watercourse forms first at the upper end of this second swamp. The whole swamp is clearly the product of filtration from water that occupies the deeper layers of the desert sand. The central watercourse did not contain larvæ where it was in motion and was tenanted by small fish; but the secondary ditches and pools contained immense numbers of larvæ, more particularly at one place, where the sand contained saline matter to such a degree that one could feel and hear the salt crystals under one's boots. M. Cépek informed us that the water of a pool crowded with larvæ contains 139 grains of salt to the litre, while the water of the Red Sea contains 463 grains. It was thought by Major Ross that proper drainage and the application of crude petroleum would suffice to destroy the larvæ of this swamp also. Beyond this second swamp there is a sand dune about fifty feet high and two or three hundred yards across. It slopes down into a basin of about a score of acres in area. A somewhat muddy mire of water covered two or three acres of the deepest part of this basin, in and around which there is some grass and other vegetation. It appears that the height and extent of this water depends to some degree on the height of water in the Nile.

This swamp is thought to emit sulphurous smells, but this is not strongly marked. There is no visible outlet and no drainage. Petroleum had been freely applied there some seven days previously, and all larvæ found were dead. Major Ross was of opinion that the frequent and proper application of crude petroleum would be sufficient there also. But should this fail, the whole place could be filled in with sand at small cost.

Two swamps, each of several acres, had been formed similarly by fresh-water filtration on the opposite side of the town, the nearest swamp not more than about three or four hundred yards from a building in which half a dozen families in the service of the Company are quartered. Each swamp was traversed by a central watercourse containing running water, and full of small fish. In each the secondary ditches, obstructed by vegetation, and the surface pools, contained large numbers of the eggs and larvæ of culex and anopheles. Small water channels had been constructed to lead water into some gardens in which there was permanent irrigation for the purpose of growing watercress in large pits. In these pits there were larvæ of both culex and anopheles. Irrigation of that sort is clearly a danger in a locality affected by fever. Careful and repeated examination was made of the large fresh-water canal at all the spots where reeds grow at its margin, but in every case without

finding mosquito larvæ. It therefore seemed possible to deal with the swamps on that side of the town in the way that had been prescribed for those on the other side, which amounts to clearing and deepening the ditches so as to let the water run and to let fish enter freely, and to apply crude petroleum where necessary. But in each case it would be easy to reclaim the swamps should drainage and petroleum fail. I understand that quinine will be continued at the same time as a preventive. Dr. Pressart is of opinion that the use of wire netting requires very strict discipline in order to be effective. It will probably not be necessary at Ismailia.

7. It became clear that the little swamps mentioned above are the breeding-grounds of the anopheles mosquitoes of Ismailia. This species is, however, present there in small numbers compared to the troublesome culex, which infests all the houses of the Europeans, and is really very vexatious. M. Reynaud, the Chief Engineer of the Company, informed us that he employs fifteen dredges in the Suez Canal, and that each dredge has a complement of twenty-two men. None of these men ever suffer from fever while they are employed on the maritime canal, not even when they are engaged, generally in November, near the salt lake, where the smell of the mud is, according to M. Reynaud, simply frightful. But not long ago the crew of a dredge suffered much from fever when at work in the fresh-water canal. We went to see this place, and found that it was at the upper end of the fresh-water canal for Port Said, at the place where it branches away just above Ismailia. The spot was within a few hundred yards of some of the little swamps mentioned above as being well peopled with anopheles larvæ. The crew of the dredge slept on board the vessel at night, and without mosquito nets. It was clear enough that the infecting mosquitoes could easily have come from the nearest filtration swamps. Larvæ were not found in the fresh-water canal there.

8. Most of the mosquitoes in the houses are bred on the spot. Water is supplied from the fresh-water canal to the quarters of the Europeans, raised by hydraulic pressure to cisterns on the top of the houses. These cisterns furnish the water-closets with water.

The sewage matter is flushed into iron tanks or cemented cisterns below ground, whence it is pumped out or removed at certain intervals. Those reservoirs contain clouds of culex mosquitoes. There is generally an aërating tube into these, which sometimes opens at the top of the house; and often there is a hole in a movable lid, which provides exit and ingress to mosquitoes, exactly as would be done were the intention to breed these insects. A careful examination was made of one officer's quarter, where all was kept in a condition of the greatest cleanliness. Petroleum was applied very frequently to any water that was left standing permanently. No larvæ could be found about the garden or houses, yet the very intelligent servant then in charge of the premises assured one there were many mosquitoes there at night. The removal of the covering of the sewage reservoir in the servants' quarters revealed at once a cloud of mosquitoes. Major Ross found the same thing again and again at Ismailia and Port Said. This is undoubtedly the great source of the mosquito supply both at Port Said and at Ismailia. The Arab quarter has a conspicuous advantage in this respect. The Arabs have no sewage arrangements, save what are furnished by the desert, and they consequently are free from the plague of house mosquitoes and from bad smells. But then their houses are built on the edge of the desert, and there is not a great number of them. An examination of Ismailia certainly predisposes one in favour of a dry system of sewage for the tropics, especially if sand is used. The wet underground tank system in the European houses has shown me the dangers of this plan in a clearer light than I ever saw it before; this and the state of the Arab quarter has enhanced in my mind the suitability of the dry system for small tropical towns, where a perfect water-borne system may for any reason be unobtainable.

After what one saw in Egypt one would have liked very much to visit Malta in connection with fever, but quarantine made that too difficult at the time. For the removal of the mosquito nuisance from the sewage tanks at Port Said and Ismailia, Major Ross has prescribed the frequent use of crude petroleum. In most

cases it can, without much trouble, be poured now and then into the water-closet receptacle, and thus be carried into the cisterns direct.

9. On the 27th September we reached Suez. The Company's offices and workshops there are on the sea, and are free from mosquitoes and fever. But the establishment whence the Company supplies water to the town, situated on its inland side, suffers to some extent from both. In a small swamp a few hundred yards from the water usine Major Ross found anopheles larvæ in footprints in little gutters. The marshy ground there was said to be affected by the state of flood in the Nile. There are not many cases of fever among the Company's servants at Suez, and it would not be difficult to cure the marsh in question. It may, however, be more troublesome to deal with Suez than with Ismailia, because the anopheles breeding-ground at Suez is outside the concession to the Company. Some effort would therefore be required on the part of the Egyptian authorities to rid Suez of malarial fever. The population of the town of Suez seem to use cesspools, and it is the case that these breed culex mosquitoes in large numbers.

One very important lesson was easily learned at the Suez waterworks: that water can be received and filtered in large reservoirs, and be kept in great open cisterns for distribution without breeding mosquitoes. The reservoirs are capacious tanks, of cemented walls, partly open, partly roofed, containing water ten or fifteen feet deep. They were quite free from mosquito larvæ, though partially covered by fine aquatic vegetation. The distribution cisterns, in which there is only filtered water, are on the top of the usine, open to the breeze that blows from the desert and agitates the surface of the water. These cisterns were also entirely free from larvæ. Immediately in front of the building, however, there was a small shallow garden cistern, of rather dirty water. This was full of culex larvæ. Nothing that came under my notice in Egypt was of greater interest than these observations. Their importance in connection with the question of a water supply for Lagos is obvious.

10. We paid a short visit to Cairo and ascertained that there is very little malarial fever in that town. There are a few pools near the city where culex larvæ are numerous, but we saw very few spots that would be favourable to the anopheles.

The workmen and employés on the railway in Lower Egypt contract malarial fever at a few places. Altogether it appears that it would be no very difficult task to stamp out malarial fever in Lower Egypt, or at least to reduce it to insignificant proportions. The result of the action of the Company in entering on this campaign will be very interesting. They take it up under the direction of Major Ross himself, the most competent of all authorities on the subject. The centres of infection are few; they are isolated; and they exist under conditions that are singularly favourable to treatment. The Company's officers are all intelligent men; they all desire to master the disease, and they believe that this can be done; they have with them medical officers who are highly educated and enthusiastic in their work. M. Chabrou, who has at present the supreme direction of affairs on the spot, is a highly cultured man, broad-minded, generous, and considerate; and he is seconded by M. Reynaud, an engineer of great experience and proved skill. If, under all these circumstances, malaria is not stamped out on the Company's concession, it is extremely unlikely that a campaign against it can ever succeed at Lagos.

The Company alone will probably exterminate malarial fever at Ismailia, where it has complete control of the sanitary and other municipal arrangements. It will thus confer a great boon on all that live at Ismailia, whether in the service of the Company or otherwise. But the same result cannot be arrived at in Suez except by the combined action of the Egyptian Government and the Company, although there is apparently much less fever there than at Ismailia.

11. On the 5th October I presented myself at the Government Health Office, in connection with the Ministry of the Interior, at Rome, where, in the absence of the head of the Department I was received with much kindness and courtesy by his assistants, one of whom most obligingly presented me next morning to the Honourable Professor Angelo Celli, at the Institute of Hygiene. Nothing could exceed the kindness of Professor Celli, who most readily showed me all the latest improvements

and advances he and his colleagues have made directly and indirectly in regard to malaria during the last two years, and he fully explained the measures, both legislative and executive, taken by his Government in regard to sanitation.

12. Several laws have been passed by the Italian Parliament, providing for the supply of quinine, and for sanitation by drainage, &c. Quinine is bought by the Government, either manufactured or in the state of raw material, and is given out pure in the form of the bisulphate or the hydrochlorate. The sulphate is not used, on account of its indigestibility. The quinine is put up in small neat glass tubes; in each tube are ten tabloids of twenty centigrams each—that is, two grams in each tube. These are sold to the public at a maximum price of about threepence three-farthings a tube for the hydrochlorate and threepence for the bisulphate, or, in round numbers, at nearly four shillings an ounce for the bisulphate and four shillings and tenpence for the hydrochlorate. By a special law of the kingdom, proprietors and contractors employing labourers in malarious districts are obliged to supply them and their families with the pure quinine of the State, both for curative and preventive purposes, in sufficient quantity and gratuitously. Failure to comply with this subjects the contractor to heavy penalties. And neglect to report such failures renders medical officers and engineers equally liable to penalties. The death of a labourer from malaria without treatment is held by law to be an accident for which damages may be recovered from the employer. The quinine tubes are sold by all druggists, and also by the shops that have the exclusive right to sell salt and tobacco. Not less than one tube of the State quinine can be sold, and with each tube printed directions are given, stating for what diseases, and in what quantity, the quinine is to be used. Professor Celli has improved the tabloids very much by having them coated with sugar, and put up of four different colours—white, red, blue, and green. This makes them more acceptable to children, especially for administration for some time after the disappearance of the actual fever stage.

There is no doubt that this law for the administration of quinine has already effected much good. It has been prepared with great care, and much thought has been given to the Regulations, approved by Royal Decree, for its practical application. I found that poor people in the Agro Romano and in the Maremma are now very generally using quinine, where they can afford to buy it. But although all this is true, yet the Italian school has not the faith in quinine as a prophylactic, or as a curative agent, that the German school, headed by Privy Councillor Professor Koch, seems to have. There seems to be no gratuitous distribution of quinine at the expense of the State, except to its own employés.

13. Though the quinine law is one of much importance, yet it appears a small measure when compared, for example, to the law of 22nd March, 1900, which, with its schedules and regulations, forms almost an entire code. This great enactment for the improving of swamps and marshy ground provides for an expenditure of two millions sterling between 1900 and 1924, on a few specified places. It is, however, far from exhausting the subject. There can be no doubt that the condition of Italy will be immensely improved in every way if the Government will persevere in the course it has laid down for itself by sanitary legislation during the last two years. The undertaking is, however, a vast one even for the Government of one of the great Powers of Europe. One very obvious desideratum in Italian legislation is an enactment to compel employers to provide reasonably good house accommodation for their labourers, in such places especially as the Agro Romano. This is, as it appears, to receive attention at an early date.

The Government is being assisted greatly by the Municipality of Rome, the Red Cross Society, the Railway Companies, and by a very strong Society for the Study of Malaria. This last society educates the public by Popular Instructions published in a handy form. Of these nearly forty thousand copies have been given away gratuitously. It has also issued three volumes, one for each of the three last years, containing papers of much interest and of great practical value on malaria.

I am indebted to Professor Celli, who is himself an active member of the Italian Parliament, for copies of many of the Laws, Reports, and other publications con-

cerning malaria in Italy, all of which—and they already form a very considerable body of literature—are well worthy of careful consideration and study by me as Governor of Lagos.

14. On the 7th October I paid a visit to the Agro Romano, in the neighbourhood of Lunghezza, some half-score of miles east of Rome, on the Roma-Tivoli line of railway. All the dwelling-houses of the surface-men, platelayers, and station employés, are there protected by wire gauze in the doors, windows, and chimneys. The doors are made to shut automatically by a special and simple arrangement of the hinges. The wire gauze now preferred is made of iron wire covered by zinc, and varnished. That of American make, fourteen meshes to the inch, seems to be most in favour, as being the best and cheapest. At some of the station houses there is no protection on the ground floor when it is used as office and store room. In that case the family lives in the upper story, and the entrance to the staircase below is shut by an automatically closing door of wire netting. Where the family lives on the ground floor there is a porch with three sides of wire netting, in which they can sit at night. This porch can be removed during winter and be re-erected in spring with very little trouble. The families I visited assured me that the protected doors and windows cause them no inconvenience. They seemed to appreciate their value. Where railway employés have to be at work at night on an unprotected ground floor they can wear hats with veils to protect the head, and gloves to protect the hands. These are supplied by the railway authorities. These prophylactic measures by mechanical protection have received so great attention in Italy that they may be regarded as the distinctive feature of the Italian school. The preference given to mechanical over medicinal prophylaxy is clearly shown by the fact that the profits obtained by the Government from the sale of quinine are not expended in the distribution of quinine gratuitously, but are given as premiums to employers that provide good mechanical protection.

Professor Celli, in his paper on "Malaria in Italy during 1901," published in the Proceedings of the Society for the Study of Malaria, says of mechanical prophylaxis:—"It was in 1898 that, after the classical experimental studies of Ross, Fermi, on my advice, put into practice in the Pontine marsh the first prophylactic experiments against malaria by means of protection to the exposed parts of the body." Systematic and regular mechanical protection was begun in the spring of 1899 by Professor Celli, and the value of this method of protection must now be regarded as fully established, and as being very great where the radical method of Ross, the destruction of mosquitoes, is difficult or impossible. Mechanical protection is not, however, always spoken of with such high appreciation as might be expected. It requires much attention and good discipline to carry it out well, and unless it is really well carried out it can hardly succeed fully. In the Lunghezza district, visited by myself without any guide, and consequently at random, I learned from those using this form of protection that it gives them a practical immunity from fever. Its employment will undoubtedly become more common.

15. In the Lunghezza district I came by chance on a camp of mountaineers that had come down for the harvest of Indian corn. They had lived in straw huts without any windows, each hut having one door. I was told that from seven to eighteen persons occupied each hut; most of them had left, but a few still remained. Those I saw had suffered in most cases from malaria. They were exsanguine, weak, and pallid. They said they earned from one to two and a half lirae a day when employed; that they had no food except maize; and could not afford in many cases to buy the Government quinine. They knew very well its value as a cure and as a preventive of fever. But neither they nor the employés I met at the railway station understood the development of mosquitoes from larvæ. The difference in the physical appearance of those living in the protected houses as compared with the unfortunate beings that had been living without protection, and to a large extent without quinine, was very striking. Some of the children living in unprotected huts presented a truly pitiful spectacle, wasted by malaria, and this up to two or three miles from the gates of Rome, poverty-stricken, helpless beings, dwelling within sight of Saint Peter's, in huts in every way inferior to a tree-house in New Guinea or a mud house in a Lagos swamp. The landed proprietors do not live on their estates in the Agro Romano; and they are, it would appear, strangers to the sufferings of the wretched peasants. Whatever may have been the indirect causes of all that suffering and misery, and it is very great, it is clear enough that the

direct cause is malaria. A very short visit to the Agro Romano is sufficient to demonstrate to any thinking person the great value of the splendid discovery of Ross, affecting as it does and will, countless millions of the human race in practically all parts of the globe.

16. On the 9th October I went to the town of Grosseto, a place that has become famous in the annals of malaria. On the way from Rome to the sea one can observe only too plainly how malaria has converted that district into a desert, peopled by a few herds of cattle and horses. Grosseto is itself still of much interest as a study in malaria. It is situated on a plain that is much more even than the Agro Romano. Immediately round the town there is little or no swamp, but there is close to it, on one side at least, a long open ditch or canal with stagnant water, choked up by vegetation, at some points a very suitable breeding-ground for mosquitoes. But the principal source of anopheles mosquitoes lies still nearer to the town. Grosseto is surrounded by a large defensive wall faced with brick. To build this unfortunate and gigantic rampart, a Medicean undertaking, much earth has been taken from the ground immediately outside the wall, thus creating a hollow, perhaps two or three hundred feet across, practically round the town. In this low space there are gardens containing open ditches, water-holes, and pools that constitute ideal breeding-places for the anopheles mosquito. I saw no place inside the walls where these insects could be developed. I walked some distance into the country and found that only a few houses close to the town gate were protected by wire netting. The country people met with said they take quinine frequently. A few houses near the town wall had wire netting in the windows, but it was seldom entire—sometimes in tatters. Grosseto as a whole is not protected by mechanical means. Dr. Pezzetti, the courteous and indefatigable medical officer of the commune, informed me that malaria has been very severe in Grosseto this season. I was sorry to learn that he is not very hopeful of any great improvement at an early date in the general health of the town.

His faith in mechanical protection by wire netting is somewhat shaken. But it is clear he has no power to have it carried out generally or carefully. It is therefore not possible to say that mechanical protection has failed at Grosseto. He does all that it is possible for him to do in having petroleum applied to pools and ditches. But even in this it is utterly beyond his power to do all that he would like to do. He has laborious duties to attend to, not only in the town, but also over a large district, including a stretch of railway, the station dwelling-houses of which are now well protected. There are no sanitary inspectors for the town, so that all the visiting and clerical work that could be performed by a lay inspector devolve on the already overworked medical officer. To this has to be added that his powers of coercion and the means at his disposal are quite insufficient. The general law for improving sanitation by draining, reclamation, &c., is, however, to be applied to Grosseto, and this may before long lead to considerable improvement. There have been many cases of fever there lately of a very severe type in spite of all that Dr. Pezzetti has been able to do. My own belief is that were he furnished with moderate means he could greatly reduce fever in the town, especially were he allowed to level its walls and to clean and keep clear the ditches round and near the town. A stranger might well enter, traverse, and go round the town and leave with the belief that it was a healthy place. It is very surprising that a few ditches and gardens should be able to convert such a solid-looking, comparatively clean and tidy, little town into a great fever centre. This is really the principal lesson that is to be learned from a visit to Grosseto. It will be difficult to cure the ditches for want of fall to produce sufficient current to prevent the breeding of mosquitoes there; but if these were kept clean and treated, along with the pools and waterholes, with petroleum now and then from April to September, fever would be brought under control. Dr. Pezzetti's great experience leads him to regard the bichlorate of quinine, used as a preventive, as his best friend.

17. On the 10th October I had the great advantage of visiting the Lunghezza district, under the guidance of Professor Celli, to examine the improvements, at once sanitary and industrial, that are being carried out there. Professor Celli selected this locality for experiment, and the methods adopted are of his devising. These operations are best represented on the farm of Cervelletta, one of the first places taken in hand for experimental improvement. It appears that this place belongs to the Duke of Salviati, a man of exceptional enterprise and wisdom among

the proprietors of the Agro Romano. The whole district was made the subject of experiments on a considerable scale during the fever season of 1901, of which a full report has been prepared by Celli and Carnevali. Their most important conclusions on the year's work are :—

(1) That the advantages derived from the use of wire netting protection are indisputable. Not more than from 2 to 3 per cent. of those protected in this way contracted primitive fever.

(2) That it is difficult to popularise the use of the protecting masks for night service.

(3) That excellent prophylactic results are obtained from four grains of bisulphate of quinine on alternate days; that this is well tolerated, as also doses of eight grains daily of bisulphate or of hydrochlorate.

(4) That euquinine (the ethyl-carbonate) is perfectly tolerated in doses of fifteen and a half grains a day for periods of many months.

18. With reference to the first of these conclusions, it should be pointed out that Professor Celli, in his general report on the Proceedings of the Society for the Study of Malaria, shows that among 4,363 persons that lived in houses completely protected by wire netting there were 921 relapses—that is 21.1 per cent.; and 83 primitive cases—that is, 1.9 per cent.

These figures approach very nearly to those given by Dr. T. Ricchi, head of the department of sanitary inspection, who shows, in the Proceedings of the Malarial Society, 1901, page 551, that of 1,600 fully-protected persons the primitive cases of fever were 2 per cent. Of 651 persons in the same neighbourhood who were unprotected, 38.7 suffered from primitive fever. It appears that the usual percentage of cases of primitive fever in the several districts that have been made the subject of experiment is, without any protection, generally about from 35 to 50 per cent. It is, however, manifest that the normal number of cases that would occur in a district without any protection whatever must be reduced by the protection afforded to a large part of the population of the same district. This indirect advantage of prophylaxy it would be difficult to estimate in figures. The above results are certainly very encouraging. Professor Celli says (Proceedings, p. 653) of mechanical protection by wire netting, that, where it can be carried out, it is the most practical and the least inconvenient of all preventive methods.

As regards the results of their experience with the protecting hats and gloves, it would seem unlikely that these will ever become popular anywhere. They must be uncomfortable to the wearer in warm weather. This would probably be felt still more in West Africa than in Italy, yet there may be circumstances in which this form of protection may be useful for temporary night service. It is desirable to have a few of the lighter form for service in Lagos.

It does not appear that the Italian observers have found any appreciable difference between the bisulphate and the hydrochlorate of quinine in their prophylactic or curative results. They are pronounced to be the most soluble, the best tolerated, and the cheapest of the salts of quinine. Four grains each day of the hydrochlorate has been found to give excellent prophylactic results. The high price of the ethyl-carbonate makes its use by the people impossible. The general results of the preventive treatment by quinine for 1901 have been tabulated by Professor Celli. Of 208 persons that had quinine regularly as a preventive, the bisulphate or the hydrochlorate, 2 per cent. contracted new fever; while of 283 persons taking euquinine, the percentage of primitive cases was 3.5. In fifty persons taking doses of quinine every second day, from four to eight grains, there occurred no fever.

Of twenty-five persons that took fifteen grains once in every five days, three became ill of primitive fever; and of fifty persons taking from four to eight grains a day, three had primitive attacks. Of sixty-four persons taking daily from four to eight grains of euquinine, six had primitive fever. From these figures it would appear that no very precise rules can yet be laid down as to the exact mode of administering quinine as a preventive. But small doses at frequent intervals is clearly the favourite method in Italy, causing least disturbance to the system, and affording the best medicinal protection. For the purposes of cure the method of administration of quinine is the following: twenty-three grains of the hydro-

chlorate daily for the first four days, then fifteen grains on each of four consecutive days, followed by seven grains daily for fifteen days; to adolescents half, and to children one-fourth, of these doses.

19. But experiments have not been limited in the lower valley of the Aniene to the administration of quinine and the use of wire netting. The efforts made at high farming in the same district are equally interesting and important. This part of the Agro Romano seems to be fairly representative of that celebrated country generally. It consists of gently rolling, undulating prairie, low, rounded, grass-covered ridges that could hardly be called hills, divided by small irregular undrained plains. The general formation is tufaceous, but in some of the hills there is a basalt-looking rock, which is quarried as railway ballast, &c. Other ridges yield tufa solid enough to supply blocks to serve for drainage purposes. This formation seems to have large absorbing powers, so that there is always much subsoil water present, which renders most of the low, flat country swampy. Generally speaking, these plains, where not improved, are crossed here and there by ditches, most of which are choked more or less by vegetation, which renders much of the water stagnant and forms very suitable breeding-places for anopheles mosquitoes. This state of matters has been aggravated in modern times by the building of railways. Owing to the rolling nature of the ground, the line usually crosses the low, flat depressions on an embankment, which is often more or less constructed out of "borrow-pits," and which makes the land on one side more swampy than it was before, thus providing excellent nests for mosquitoes. In no other country can one see more clearly the great sanitary dangers that may be created by railways that are built in fever countries without due regard to the general principles to be followed in the struggle against malaria. This adds one more important branch to the education of an efficient railway engineer, and brings him into direct contact with the medical officer. These considerations are of great importance in such a place as Lagos. The great aim of the improvements carried on at and near to Cervelletta is to effectively drain these plains. Down the centre of the plain at Cervelletta there runs a small stream with sufficient fall to breed no mosquitoes. Drains are led into this from both sides. These latter are sufficiently deep to have waterways at the bottom constructed of blocks of tufa. The whole is covered over so as not to interfere with cultivation, and at the same time to render them inaccessible to mosquitoes. A considerable number of fields have been drained in this way, and are at the same time irrigated, when necessary, by tapping the drains at certain places provided with small reservoirs and sluices, from which distributing channels radiate.

On land improved in this way there are no pools, no open choked-up ditches with stagnant water. It would seem that there is abundance of water in the Agro Romano to serve for the purposes of irrigation, wherever this is required. At first sight it would have appeared to one that there would be want of sufficient fall for such works as these described, but even a cursory examination of the water-courses is sufficient to show anyone that the incline is so considerable as to keep the water in all the drains and courses in active movement. The cultivation of Cervelletta is carried on by natives of Lombardy—men that thoroughly understand irrigation and good farming. The results have been all that could be desired. The tufaceous soil is rich and deep, and yields splendid crops. As many as six or eight crops of clover are cut from the same field in twelve months. With their present arrangements, which are not yet perfected, it appears they reap thirty bushels of wheat to the acre. On some of this land, cultivated as market gardens, there were at the time of my visit the richest crops of tomatoes I have ever seen. Nothing could be more striking than the contrast between the improved and unimproved land. On one side of a ditch there will be only a rough, scanty, innutritious mixed herbage, or the stumps of a poor crop of maize; on the other side, a most luxurious crop of emerald-green clover, or a patch of great Savoy cabbages.

The straw huts of the labourers at the same place were all protected by a small porch of wire netting. The door closes automatically by means of a small weight attached to a cord that runs in two glass rings. A second door closes the entrance to the hut. It is very clear that the employés at that place can do much more and much better work than could be done by them under previous conditions. It would seem to be quite possible to deal with the Agro Romano in this way on a great scale, vastly improving its productive power, while at the same time converting it into a healthy country. The experiments have already been carried so far as to furnish a most striking and instructive object-lesson, and that too at the gates of Rome.

Its immense importance cannot fail to be recognised and appreciated before long. Undoubtedly the system now practised there would, if extended to the whole of the vast areas requiring it, effect surprising changes in the condition of Italy, socially and economically. At certain spots some filling up of pools and small hollows is being done, but most of the necessary drying of land can, it seems, be effected by draining. The material for reclamation is taken from the nearest ridge. The low hills and ridges are left without improvement. They will doubtless be put into good grass eventually. The question of drainage is somewhat different there from what it is at Lagos. At the latter place the filling-in material is generally sand, which speedily absorbs rain and allows it to filter away, leaving only few pools, owing to the presence in the sand and sandy soil of very little mud or clay.

It should be said of these experiments in the Agro Romano that they are all of a strictly practical nature, and that they aim at no impossible, unattainable ideal.

At certain places other than the Cervelletta and the Lunghezza districts, however, filling-in operations have in recent years been conducted in Italy on a great scale, but on principles different from what their engineers and medical officers now recognise to be necessary. They see clearly that the modern doctrine of malarial fever, all built up on the epoch-making discovery of Ross, does not demand that swamps and lakes be filled up merely to the extent of covering the noisome mud at the bottom, but rather that such places should, where possible, have salt water let into them freely; that they should in many places be deepened; that their margins should be regulated; and that filling in should take place only where it can be carried out in such a way as to not create pools and ditches of stagnant surface water. These principles seem to me thoroughly sound, and such as should be applied at Lagos.

I am still of opinion that salt water could with advantage be let more freely into swampy ground or into ditches in Lagos. To this subject it will be necessary to give renewed close and careful attention. Before returning to West Africa I am desirous of studying this interesting question at Amsterdam, to see the effect of the admission of salt water into the canals of that city.

I am induced to take this step by the perusal of an excellent article on Malaria in Holland, by Dr. H. J. M. Schoo ("Atti della Società per gli Studi della Malaria," Vol. iii.), in which he says:—"The city of Amsterdam is quite a good example of the efficacy of salt water as a prophylactic measure against malaria. Formerly the water of the canals in the interior of the city was fresh. Then cases of malaria were numerous. At the present time sea water is, on sanitary considerations, made to enter the canals, and malaria has all but disappeared, notwithstanding the fact that it still exists in the outskirts of the town. Anopheles are now found only at the periphery of the city."

As this matter is really one of sanitary engineering, I would propose that I should be accompanied by Mr. Reeve while making this examination, as I have no doubt that this officer would be able to turn to practical advantage what we might learn on this subject in Amsterdam.

In connection with this proposal, it should be mentioned that Italian observers have not found mosquito larvæ in water containing salts in the proportion of as much as one to the thousand. The highest grade of salinity associated with the presence of mosquito larvæ was found by E. Perrone to be .8 to the thousand. The degree of salinity was measured by a determination of the chlorides present in the water. This proportion does not leave in the mouth the taste of salt water.

I have, &c.,
WM. MacGREGOR.

The Right Honourable
The Secretary of State for the Colonies.

No. 2.

THE EARL OF ONSLOW (FOR THE SECRETARY OF STATE) to GOVERNOR SIR WM. MACGREGOR (LAGOS).

SIR, Downing Street, March 11, 1903.

I HAVE the honour to inform you that I have read with great interest your report of the 22nd of October,* on the visit which you made to Egypt and Italy last autumn to study the question of malarial fever, and have communicated copies of it to the Governors and High Commissioners of the West African Colonies and Protectorates, the Foreign Office, the Medical Advisers of the Colonial Office, the Schools of Tropical Medicine, the Crown Agents, and the Consulting Engineers for West African Railways.

I have pleasure in informing you that your public spirit in devoting a great part of your recent leave of absence to the study of malaria is appreciated. The experience which you have gained during the visit will no doubt be of great value to you in dealing with health problems in Lagos; and I shall be prepared to support cordially, as far as funds permit, any further measures which you may propose for the prevention of malaria in the Colony, and shall be glad to receive reports from time to time as to the success of such measures.

I have, &c.,
(FOR THE SECRETARY OF STATE),
ONSLOW.

No. 3.

HIGH COMMISSIONER SIR F. A. SWETTENHAM (FEDERATED MALAY STATES) to MR. CHAMBERLAIN.

(Received April 13, 1903.)

SIR, Government House, Singapore, March 19, 1903.

I HAVE the honour to forward, for your information, the enclosed copies, in duplicate, of the Report on the Institute for Medical Research, Federated Malay States, for the year 1902.

I have, &c.,
F. A. SWETTENHAM.

Enclosure in No. 3.

ANNUAL REPORT FOR 1902.

The Institute for Medical Research, Federated Malay States,
SIR, Kuala Lumpur, February 4, 1903.

I HAVE the honour to forward you my third and last Annual Report on the Department for Medical Research.

2. The 4th instant marked off three years since my arrival in Kuala Lumpur to begin the organisation of a Pathological Institute. As that Institute has been gradually evolved into the Department for Medical Research of the Federated Malay States, and has been practically affiliated with the London School of Tropical Medicine, it will not be out of place to review the past three years and note the stages of development.

3. On my arrival here I found that though there was a general agreement that a Government Pathologist was greatly needed there was a nebulous idea only of what such a Pathologist should do, and what form his Department should take. Plans

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* No. 1.

for a building had been prepared, a site chosen and $8,500 provided to meet the expense of its erection and equipment.

4. A moment's view of the situation rendered it apparent that a large enough provision had been made to do a useful, though limited, amount of research work. But it also made plain that at the end of my engagement such work would probably have to cease unless the future was provided against.

5. Fortunately for the profession of medicine Sir F. A. Swettenham was then Resident-General. In an interview with him a few days after my arrival here I pointed out the favourable situation of Kuala Lumpur for a Central Research Institute, the wisdom of providing for more workers than myself, and the good effect that a central well-equipped Institute would have on the State Medical Services.

6. The then Resident-General agreed with me and I instructed the State Engineer to draw up another plan for the main building in accordance with my views. This was done. It increased the proposed expenditure on buildings and on a refrigerating plant to $20,000. This was sanctioned provisionally and when submitted to the Secretary of State he approved of it as follows:—

> SIR, Downing Street, May 10, 1900.
>
> I HAVE the honour to acknowledge the receipt of your despatch of the 5th ultimo, forwarding copy of correspondence on the subject of the proposed Pathological Institute in the Federated Malay States and stating that you have approved of the increase in the estimated expenditure on the buildings from $8,500 to $20,000.
>
> 2. I am glad to note the evident intention of the authorities of the Federated Malay States to spare no effort to make the work of the Pathological Institute a success.
>
> I have, &c.,
> J. CHAMBERLAIN.

7. Since the then Resident-General met my view of the matter and the Secretary of State approved of the extension the Institute has grown steadily to its present compactly organised, concrete form.

8. Since the 29th of April, 1900, when you took up the Office of Resident-General I have had to deal with you in all matters connected with the organisation of the Institute. It has been a constant pleasure to me that you appreciated the possibilities of this Department and that by your continued interest in it you have enabled me to complete its organisation within three years.

9. During the first year the slender equipment of the Department was housed in a small ward of the District Hospital. My time was engaged in training native assistants, in clinical and post-mortem observations on beri-beri and malaria, in studying the hygenic conditions of the various peoples of the Peninsula and in making an estimate of the professsional needs of the members of the State Medical Services.

10. I found that although the Medical Officers were willing they had not the training and but little time to assist me in the proper work of a Department such as this. The voluntary assistants who were expected to have taken advantage of the Institute failed to appear and I found myself at the end of the year working alone over a vast field of unsolved medical problems.

11. In the course of a conversation with you early in January, 1901, I pointed out that there was grave dissatisfaction amongst the Medical Officers owing to their not being able to train themselves in modern methods of clinical and post-mortem examination except once in six or seven years, and I suggested a scheme whereby the Head of this Department could be assisted and the Medical Officers given the longed-for opportunity to post themselves. The scheme was that three trained European Assistants to the Director should be appointed and that one of them should be utilised as a relief to take over a medical district and so enable the District Surgeons to enter the Institute in rotation for three or four months' training.

12. After considerable paper discussion of the project two assistants were approved of by the Secretary of State on 30th May, 1901. This marked the second

large step towards making this Department a permanent one and adequate to carry on the most advanced research work. That the two assistants to the Director have only arrived as I take my departure is unfortunate. But during the nearly three years in which I have worked alone it has been a pleasure to prepare for them and to anticipate the great assistance they will be to my successor.

13. In February, 1901, the main building of the Institute was ready for occupation and a sufficient equipment was on hand to justify me in advising you to issue an invitation to all scientific workers, irrespective of nationality, to make use of its facilities. This invitation has so far been taken advantage of by Dr. Carougeau, veterinary expert of the Pasteur Institute, Saigon, who informed you of the benefit he derived from his visit. He was able to determine that the so-called Rinderpest of the Malay Peninsula is really Septicæmia Hæmorrhagica. Professor Axel Holst, of Christiana University, has also taken advantage of the Institute during the past year. His visit was welcome and pleasureable, and, he has informed me, of service to him. Dr. H. E. Durham, Leader of the School of Tropical Medicine Beri-beri Commission, has taken full advantage of the resources of the Institute since April, 1902.

14. When the Institute becomes better known you may look forward to a regular influx of scientific workers whose researches, together with those of the Director and his staff, must be of direct benefit to the Government and people of the Malay Peninsula as well as to science generally.

15. In August, 1901, the High Commissioner consenting, the name of this Department was changed from Pathological Institute to Institute for Medical Research and the title of its head from Director of the Pathological Institute to Director of the Institute for Medical Research.

16. In May last you approved of my proposal that the higher class boys graduated by the Victoria Institution should be admitted to this Department for a preliminary training in medicine whence they are to be sent to either Hongkong or Madras to qualify as physicians and surgeons. At present there are two bright youths, one Chinese and one Tamil, taking advantage of this opportunity. I trust that they are but the head of a long stream of native boys who will ultimately join the clinical staff as capable Medical Officers.

17. The final step towards insuring the permanency of this Department was taken in February, 1902, when I proposed to you that negotiations be opened with the London School of Tropical Medicine for the affiliation of the Department with that School. A scheme was submitted to you semi-officially of which you approved and in part submitted to the High Commissioner. Fortunately for all concerned Sir Francis Lovell, representing the London School of Tropical Medicine, arrived in Singapore shortly afterward and the High Commissioner offered him the Headship of the Department as a gift to that School. It was accepted and an agreement soon after reached that the Medical Superintendent of the School should succeed me on my retirement. Needless to say, I felt both gratified and relieved that our conjoint efforts to found a first class Institute for Medical Research had succeeded. The pleasure will be intensified to me if a real affiliation is accomplished on the basis of the Memorandum submitted to you on 8th December, 1902.

18. A glance at the accompanying plan* will indicate better than words what has been accomplished in the way of organisation since my arrival here. All buildings stippled black have been built and equipped. The main building (marked Institute) contains photographic, bacteriological, chemical and physiological rooms, and a large room for general pathological work, a museum and library combined and offices. The post-mortem room is equipped with a cold chamber and refrigerating plant which makes it possible to do reliable autopsies. This building also contains a large room for the preparation of culture media, &c. The animal house is sufficiently equipped for the larger animals. But a second one has been found necessary for the smaller animals and is to be erected during the current year. A veterinary reserve, 400 by 200 feet, has been partially prepared for doing experimental work. Complete isolation is obtained by an inner and outer fence of barbed-wire and by surrounding the whole Institute grounds by a combined barbed-wire-and-bamboo fence. A horse and cattle shed and an incinerator are provided for in this year's estimates and will shortly be

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* Not printed.

erected. Quarters have been provided for the native staff. A large piece of the Institute ground, 480 by 320 feet, is held in reserve for extension of the present work. The plan indicates the compactness and completeness of the whole Department.

19. During the organisation of this Department its proper work has not been neglected. Much time and thought have been spent in sowing seed for future Directors and visiting workers, but thanks to a loyal and hard-working native staff the present Director has reaped all that he could hope to reap without the assistance of trained Europeans.

20. There follows a list of works published by your Director since he took up the work of the Department:—

(*a*) The Effect of Ether and Chloroform on the Nervous System of Rabbits and Dogs.—"Journal of Physiology."

(*b*) A Supplementary Note on the Effects of Ether and Chloroform on Dogs.—"Journal of Physiology."

(*c*) The Changes in the Central Nervous System in Beri-beri.—"British Medical Journal."

(*d*) The Malarial Fevers of British Malaya.—"Studies from the Institute for Medical Research, F.M.S.," Vol. I. No. 1.

(*e*) The Etiology and Pathology of Beri-beri.—"Studies from the Institute for Medical Research, F.M.S.," Vol. II. No. 1.

(*f*) Beri-beri in Monkeys.—"British Medical Journal" (soon to be published).

21. In addition to the above complete works a large mass of beri-beri data has been collected which I have not had the requisite time or European assistance to work out. This is unfortunate, as I should like to have rounded off my investigations of this disease while actually at the head of this Department. Eighteen months ago I anticipated this pass, and after a conversation with you I volunteered to give the Department another couple of years of my time to thoroughly organise it and complete my investigations. I think I may remark that it was somewhat unfortunate for my work that the plan fell through after having met with your approval. It had one good effect, however, for it stimulated my desire to insure a fair future for this Department and its work, if not in my hands then in another's. My proposal for the affiliation of this Department with the London School of Tropical Medicine was the result.

22. It is my intention to prepare another Study from this Department on the Pathology and Treatment of Beri-beri. It will enforce the truths of the Etiology of Beri-beri, published as Vol. II. No. 1 of Studies from this Department.

23. It will interest you to notice the accompanying tables of Estimates and Expenditures in connection with the organisation and work of this Department for the past first three years of its existence.

24. I would again bring to your notice the loyalty and intelligent hard work of my native staff.

25. I regret that I am not able to personally hand over the Institute to my successor. If it is to be Dr. Daniels I have no misgivings, but only high hopes, for the future of a Department which it has been pleasurable to organise, administer and do the research work of.

I have, &c.,
HAMILTON WRIGHT,
Director,
Institute for Medical Research, F.M.S.

The Resident-General, F.M.S.

TABLE No. 1.

Personal Emoluments and other Charges.	1900. Estimated.	1900. Actual amount spent.	1901. Estimated.	1901. Actual amount spent.	1902. Estimated.	1902. Actual amount spent.
	$	$ c.	$ c.	$ c.	$	$ c.
1. Director, I.M.R.	5,000	4,583 26	5,000 00	5,000 00	5,000	5,000 00
2. 1st European Assistant ...	—	—	—	—	3,000	1,282 93
3. 2nd European Assistant ...	—	—	—	—	3,000	—
4. 1st Native Assistant ...	840	404 58	1,500 00	537 58	1,200	1,200 00
5. 2nd Native Assistant ...	—	—	780 00	780 00	960	390 00
6. Interpreter	—	—	—	—	1,200	442 00
7. Clerk	600	240 00	600 00	600 00	720	720 00
8. Attendants	480	306 36	720 00	693 84	780	638 18
9. Engineer	—	—	—	—	600	520 00
10. Peons and P. Pullers ...	—	—	360 00	325 14	360	323 65
11. Watchman	—	—	—	—	144	144 00
12. Contingencies	200	198 26	—	—	—	—
13. Horse and 'Rikisha Allowance.	240	168 00	480 00	370 00	360	360 00
14. Travelling Allowance ...	600	598 58	800 00	769 73	1,000	919 47
15. Maintenance of Laboratory	10,400	8,661 95	9,127 78	7,865 67	11,200	11,192 91
16. Upkeep of Grounds ..	—	—	240 00	236 64	384	362 49
17. Cost of publishing Study No. 1.	—	—	—	—	—	1,198 25
Total	18,360	15,160 99	19,607 78	17,178 60	29,908	24,693 88

TABLE No. 2.

Buildings, &c.	1900. Estimated.	1900. Actual amount spent.	1901. Estimated.	1901. Actual amount spent.	1902. Estimated.	1902. Actual amount spent.
	$	$ c.	$ c.	$ c.	$	$ c.
1. Pathological Institute ...	20,000	12,518 80	—	—	—	—
2. Pathological Institute, two Latrines, Fixtures and Animal House.	—	—	16,101 38	16,101 38	—	—
3. Two Entrance Gates... ...	—	—	—	—	1,000	1,000 00
4. Horse and Carriage Shelter	—	—	—	—	600	—
5. Brick Drains to complete drainage system of Institute.	—	—	—	—	2,500	2,291 00
6. Fixtures for Institute ...	—	—	—	—	1,000	1,000 00
7. Porte Cochère for front of main building.	—	—	—	—	1,000	200
8. Enclosing three sinks in main building.	—	—	—	—	300	300
9. Filling and Levelling of Institute Grounds.	—	—	—	—	4,000	3,683 09
Total	20,000	12,518 80	16,101 38	16,101 38	10,400	8,474 09

—	Total.	
	Estimated	Actual amount spent.
	$ c.	$ c.
Establishments and Other Charges, Table No. 1.	67,875 78	57,033 47
Buildings, &c., Table No. 2	46,501 38	37,094 27
Grand Total	114,377 16	94,127 74


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