material. In the country where relations are clear it would only be necessary to have cases of genuine udder tuberculosis, and to ascertain how long the illness had existed in the animals; what people, especially children, had partaken of the milk and the butter made from it; whether, and how, the milk was boiled; and whether the persons concerned had fallen ill of tuberculosis in the course of one to two years; and, of course, the form which it took.

Very numerous letters have reached me in the course of the last year from people who have told me that they themselves or their belongings had drunk unboiled milk affected with *Perlsucht* for a longer or shorter time, and had remained healthy. As it is not now possible to examine these cases as to their accuracy, I will not enter upon the matter; but I should like to request the International Committee to bring its influence to bear, so that instead of the quite unserviceable material now existing, reliable observations should be collected, including, of course:

1. Cases of alleged infection from ingesting milk infected with *Perlsucht*, having regard to the conditions advanced by me (necropsy, exclusion of other sources of infection, condition of other people who have drunk the same milk, proof of tuberculous udders).

2. Cases of absence of infection after partaking of milk infected with *Perlsucht*, likewise under the control of the required conditions (proof of udder tuberculosis, sufficiently long observation of the people, statement as to whether and how the milk was boiled).

Provisionally we can only say that the injurious effects of milk infected with *Perlsucht* and its products are not proven. What these facts signify in relation to the immensely frequent opportunities of infection, I leave to the individual judgement.

Obviously this opinion only holds good in the case of mankind. It is a matter for agriculture and veterinary science to determine how far milk infected with *Perlsucht* is detrimental to cattle, and what measures should be taken to combat the danger which perhaps exists. Measures concerning meat and milk infected with *Perlsucht* which are meant to combat human tuberculosis cannot be well founded at the present time. Further, such measures would be very costly, because of the compensation which would have to be paid for animals judicially seized, and on account of the immense quantity of milk which would have to be inspected. It is, however, decidedly more fitting not to lay out a sum of this kind for something which is far from being established, but to apply it rather to such measures as must with certainty lead to a decline of human tuberculosis.

In this connexion I can only repeat what I said in my London address: The fight with tuberculosis must not be fought on wrong lines if it is to have a real result. It must aim at shutting off the chief, indeed we may say almost the only, source of infection. This is those consumptives who in consequence of the unfavourable conditions under which they live, or because they obstinately set aside the simplest rules for the prevention of infection, are a danger to their companions. In some way or other we must look after these sick people, either by procuring for them more favourable conditions, for example, as regards dwelling places, or by so sheltering them in suitable institutions that they cease to be a danger to their neighbours.

After the experiences we have had of other infectious diseases, we must come to the conclusion that in no other way can anything be attained, and therefore I should like urgently to advise that for the future this task should be kept to the fore in the battle against tuberculosis until it has been accomplished.

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A Lecture ON MALARIA.

Delivered to the Students of the Practice of Medicine Class, and of the Clinical Medicine Class, of Professor T. McCall Anderson, of Glasgow University.

BY SIR WILLIAM MACGREGOR, K.C.M.G., C.B., M.D., LL.D., D.Sc.,

Governor of Lagos.

GENTLEMEN,—It is with great pride and pleasure that I avail myself of the privilege of addressing you here to-day on the subject of malaria. It is now upwards of thirty years since I sat on the seats you now occupy. I then listened to the lectures of the highly accomplished and distinguished professor (now Sir William) Gairdner. That great teacher has had a most fit and proper successor in the illustrious physician that now occupies this famous chair. To Professor McCall Anderson, and to Dr. Thomas Reid, of this city, I owe my early introduction to those scientific studies that more particularly require the use of the microscope in pathology and parasitology. To my very great regret, events have deprived me of the opportunity of cultivating the more purely scientific branches of the medical profession; but at the same time circumstances often require me to apply in practice the principles worked out and established by other men. This is specially the case with regard to malaria. In speaking of that subject to-day I therefore confine myself as far as possible to what I know best, and to what will be most useful to you—the purely practical side of the question.

IMPORTANCE OF THE SUBJECT.

In the first place it should be pointed out that this study is one that has a direct bearing on the development of our Colonial Empire. It is true that malaria is practically extinct in the islands of the United Kingdom; but we possess the lion's share of the malarial areas of the earth; and at the same time no other great Power is so much, or is likely to become so much, dependent on its foreign possessions as we are. But we hold those vast territories subject to the tyranny of the destructive giant Malaria, who bestrides the globe, and exacts his yearly tribute of scores and scores of thousands of human lives from white and black indiscriminately. Few of our great colonial possessions in the tropics or subtropics are exempt from this widely distributed malady. France and Germany, with their great tropical possessions; Italy, with her two million cases of malaria a year on her own soil; and the United States of America, are all deeply interested in this subject, and they are doing their duty towards it with generosity and devotion, in proportion as they become aware of its importance. From the earnest workers of those nations we can, and therefore ought to, learn much. We have to recognize the fact, however, that our responsibilities as a nation are greater than theirs, in this respect, in the proportion represented by hundreds of millions of human beings. This heavy national, imperial responsibility can be illustrated to you by the statistics of malaria in India alone:

MALARIA IN INDIA IN 1900.

Mortality from fever:

Native population	...	4,919,591
Admissions for malaria during the year:		
European troops (60,553)	...	18,679
Native troops (123,463)	...	39,601
Convicts (121,811)	...	43,594

The significance of these figures you can grasp more easily if you reflect that the annual Indian mortality from fever exceeds the total population of Scotland by half a million.

Imagine what would be the terror and consternation produced in Europe were this appalling mortality centralized and located so that the whole population of Scotland became extinguished by malaria in 1903, and the whole of the subjects of the Kingdom of Holland succumbed to the same malady in 1904, followed by those of Sweden in 1905. It is because the Indian mortality is at a distance, and for the reason that it affects a different race, that it does not appeal to the imagination in this country. We are sometimes told that we are an imperial race. Truly malaria demands from us, as a ruling people, most earnest, energetic efforts in India. The question of India alone is enough to show you clearly the nature of our imperial responsibility with regard to malaria. How we stand with respect to the special case of Lagos we shall see further on.

NATURE OF MALARIA.

The significance and origin of the word "malaria" was vividly presented to me a few days ago in the *Agro Romano* by the wife of the station master at Lunghezza. She asserted in perfectly good faith that the night air of that place was so thick, and bad, and poisonous, that, when the railway was being made, the labourers had, to escape death or dreadful disease, to go to Rome every night to sleep. She assured me that if I slept a single night in that district with the doors and windows open, the night air would probably kill me. In that classic land of malarial fever the mind of the peasant is at the present moment somewhat confused between bad air and bad mosquitos.

I shall not waste your time by discussing the term "malaria" or "malarial fever," for such discussion generally ends in proposing a new name which dies at its birth. It required the magnificent discovery of Major Ross to give the death blow to the miasmatic origin of this disease. In my last annual report on the Colony of British New Guinea, it is stated that the best way to escape fever there is to use always a good mosquito net, and to avoid stimulants. Many others had, as the result of observation, come to the same conclusion with regard to the mosquito net. I thought then that an atmosphere charged with fever germs surrounded one at night, and that inside my mosquito net I breathed filtered air. This led to a practice that was right, though the reasoning was wrong, so very far wrong that I for one never connected mosquitos with the occurrence of malarial fever.

Such theories might have lived for generations but for the wonderful pertinacity of Major Ross, coupled with his splendid powers of observation, qualities that have given him the proud place of one of the greatest benefactors of our race. I was a student in this city during the infancy of antiseptic surgery. I have thus witnessed in my professional life the advent of the two greatest discoveries of the last century, with which the names of Pasteur, Lister, and Ross will for ever be associated. You all know how Ross's investigations originated. The way had been prepared by Laveran's discovery in 1880 of the malaria microbe in the red blood corpuscles of man.

Manson's memorable discoveries in connexion with the study of filariasis, and his suggestions with regard to the position of the mosquito in malaria, have also to be remembered.

Ross worked at the malaria problem between 1895 and 1899, by dissecting mosquitos fed on malarial patients; and he demonstrated that the parasites found by Laveran pass a hitherto undiscovered stage of their existence in the mosquito, and are then inoculated into man by the puncture of that insect. The whole problem was thus solved exclusively by the researches of Ross, based on the reasoning of Laveran and Manson. It is for this great work that Major Ross now receives the magnificent, well-earned Nobel prize; and for which he lately was awarded the Cameron prize at Edinburgh.

The nature and life-history of the malarial parasites can only receive from us to-day a side glance, and that only as far as is necessary to elucidate the curative and prophylactic measures discussed further on.

Three of the nine known haemamoebidae are found in the blood of man. Ross divides them all into two genera, making the aestivo-autumnal parasite a genus by itself. The parasites appear first as small amoeboid bodies in or on the red blood

corpuscles. They enter the latter and convert the haemoglobin into melanin. They arrive at maturity in from one to three days, according to the species; and then mature into forms that (a) either are asexual and multiply by segmentation and sporulation, filling the blood with swarms of fresh spores that produce accessions of fever and attack anew multitudes of red blood corpuscles; or (b) the amebulae develop into male and female gametocytes that circulate in the blood until they are drawn into the stomach of the mosquito, where the female is fertilized, and finally produces many hundreds of young filamentous blasts that ultimately find their way into the salivary glands of the mosquito, and thence by puncture into the human circulation. These changes constitute "the cycle of Ross," certainly one of the marvels of a marvellous age.

The malarial parasites thus present a double form of life that may be compared to a split ring, one side of which is fitted for reproduction by segmentation and sporulation, the other by reproduction through male and female elements. The one side of this ring passes into the other at the point where the gametocyte is transferred from the blood of man to the stomach of the mosquito. This ring may be interrupted or weakened at different parts and in different ways.

Koch attacks the parasite in the human body. Celli, with his wire netting, stand between man and mosquito, to defend the former from the latter. Ross boldly attacks the mosquito himself. At Lagos we follow the favourite practice of each one of these three leaders, but before I proceed to deal with their methods I should tell you what Lagos is like.

It is a notorious haunt of malarial fever, and presents many special difficulties. The country is perfectly flat for miles inland from the sea, and is geologically a combination of lagoon, swamp, and low-lying sand, or mud, or clay. The town of Lagos, with two score thousand people, of whom about 1 in every 200 is a European, stands on an island that nowhere rises 20 ft. above the sea. It is surrounded by a salt or brackish water lagoon, and contains many swamps, partly of fresh, partly of brackish water.

Both malarial and general mortality have been very great among young children. During the nine years from 1892 to 1900, 45 children out of every 100 died during their first year. In 1899 the mortality among children under 1 year seems to have been about the average. The total number of such deaths was that year 864. Of these no fewer than 321 were from fever. This was more than half of the total number of deaths from fever in that year. In 1900, three-sevenths of the total mortality was in infants under 1 year. Deaths from fever made up one-fourth of the total mortality. Remember that these figures apply to an autochthonous community, and that consequently they demolish the idea of racial immunity. Lately Dr. Best examined the blood of 320 children, all presumably healthy, living in the town of Lagos, and under 15 years of age. Forty-five per cent. had tropical ring parasite in their blood; and 5 per cent. had pigmented leucocytes. It may therefore be assumed that 50 per cent. of the apparently healthy children of Lagos harbour malarial parasites in their blood; no less than 86 per cent. of those under 2 years were so affected; but only 7 per cent. of those between 10 and 15 years. This simple statement will be enough to show you the terrible necessity that forces the Government of the Colony to grapple with this subject. The question whether malaria can be controlled or not is practically one of stagnation or progress to the West African Colonies generally.

As regards the diagnosis of malarial fever we must be brief. The microscope is indispensable. Lately I met a medical officer in "the bush" who had a case under his care which might have been sunstroke or malarial fever. He had no microscope to settle the question. There should always be a microscope at hand, and every medical man should be able to use it in all cases that might be malaria. When I say that every medical man should be able to use the microscope in malarial diagnosis, it is meant that any of you in practice, even in this country, should be able to do so, for any medical man may any day have to treat a case of malaria from West Africa or elsewhere; and duty to such a patient requires that you master malaria wherever your practice may be. As to how the microscopic examination should be carried out, I now present to you a summary of a communication I have kindly had from Major Ross on his new method of diagnosis:

By the plan generally followed hitherto, about 1 c.cm. of blood is spread out over about 4 square cm., and this is examined either wet or dry. The film being very thin, many fields may have to be examined to find a parasite. The opacity of the blood, which requires the film to be very fine, is due to the haemoglobin.

By the new method, Major Ross takes about 20 c.mm. of blood on a slide, and spreads it slightly by means of a needle over an area about equal to that of an ordinary glass cover. It is allowed to dry. Then the film of blood is covered by an aqueous eosin solution. This solution is the one usually employed to produce the Romanowsky effect. The eosin solution is allowed to remain on the film about a quarter of an hour. It abstracts the haemoglobin of the dried corpuscles, and stains the residual mass of corpuscular stromata with the adherent parasites, the leucocytes, and blood plates. The eosin solution is then gently washed off, and a weak solution of the methylene blue employed for the Romanowsky method is run over the film and left for a few seconds. Then the blue is in turn washed off gently, and the film is dried and mounted in Canada balsam. A moment's reflection will show one that this method is an enormous advance in saving time and in certainty of diagnosis.

QUININE, AND KOCH'S PREVENTIVE METHOD.

Koch has shown by his experiments in Kaiser Wilhelm-land, and by his observations in Java, that under favourable circumstances, such as a small community, isolation, and discipline, malarial fever can be completely controlled by the systematic administration of quinine in sufficient doses. A pupil of Koch, Stabsarzt Dr. Bludau, repeated last year the same practice, with similar results, on some of the Brioni Islands, off the Dalmatian Coast. Koch's experience is convincing within the limitations mentioned above. The practical extinction of malaria in Germany is attributed by the same great authority to the use of quinine in that country. It would be hazardous to say whether the conquest of malaria in the United Kingdom should be ascribed chiefly to quinine or to drainage. No doubt each had a large share in it. One would be inclined to think, after seeing Holland, that the great amelioration arrived at there some years ago was due more to quinine than to drainage, for the country remains full of ideal breeding grounds for mosquitos. It is, however, perfectly certain that quinine exerts a powerful preventive action against malaria. No one with experience of the subject would dispute its curative effect.

At Lagos all public officers are supplied with quinine gratuitously, to be taken as a preventive. Nominal lists are prepared, and each individual is invited to state how much quinine he requires, and how he takes it. Some take $2\frac{1}{2}$ gr. a day, some 5 gr. every second day, and so on. It really does not seem to make very much difference how the quinine is taken so long as an adult individual absorbs at least 15 gr. a week. Ross prefers 5 to 10 gr. a day before breakfast. Koch advises 1 gram every tenth and every eleventh day. Celli has good results from 4 gr. every two days. The latest Italian experiments seem to show that only about 2 per cent. of those taking quinine as a preventive have attacks of primary fever. It seems to me personally that no European that cannot, or that will not, take quinine, both curative and preventive, should be sent out to, or if sent out to, should be retained in, our malarial colonies. Not only does such a person risk his own health and existence, but he is also a standing public danger as a centre of infection for other people. It will doubtless become a rule before long that officers that do not take quinine and that suffer from malarial fever will receive no pay when off duty on account of that disease.

In Italy we have on this matter a much more stringent law in another direction.

If a man working under contract dies of malarial fever without having been supplied with quinine in sufficient quantity by the contractor, the employer may be sued for damages, in addition to being prosecuted criminally.

The Dutch Government gives away gratuitously enormous quantities of quinine in Java, and does so with very favourable results. The Italian Government has passed wise and stringent laws for providing labourers with quinine at the expense of the employer. The medicine is prepared and put up by the Government, and sold at a maximum price fixed by

law. But that price would be considered very high in this country. In Lagos all officers and employes are, as already stated, supplied gratuitously with quinine; but besides this there is a special vote of several hundred pounds each year for the purchase of quinine to be distributed by the Lagos Ladies' League to the children of Lagos. It is also given free of charge at the Government dispensaries.

One of the chief difficulties in carrying out Koch's method on a great scale is its cost. To administer indiscriminately to the whole population of the Lagos territory as much quinine as an average of 1 gram every eleventh day would, for the year, cost in quinine alone not less than £220,000, a sum nearly equal to the total ordinary revenue of the Colony.

Koch's method, however, is not, as is often supposed, based on the indiscriminate administration of quinine to the whole population. It requires the medicine to be administered only after the indispensable microscopic examination of blood has shown the individual to have the malarial parasite in his circulation. This examination might considerably reduce the quantity of quinine required, but it would add enormously to the medical staff. It is thus impossible to carry out Koch's system wholesale, though it can clearly be worked successfully on a small scale.

In urging on Europeans the regular use of quinine as a prophylactic, one very frequently is met by one or other of two objections: that Koch has shown that blackwater fever is produced by quinine; or that if a person constantly takes quinine, it will begin to lose its effect.

As a matter of fact, Koch and his school use quinine very freely in the treatment of fever; for an adult from 1 to 2 grams as a dose. His usual treatment seems to be a gram of the hydrochlorate every morning, as long as parasites are found in the blood; then a gram each seventh and eighth day for at least two months afterwards. Bludau went so far as to give to Brioni children of 4 years a gram dose on each of four successive days, and that apparently with decided advantage. Koch appears to believe that quinine given at first in senselessly large doses may sometimes produce blackwater fever; and if symptoms of that complication are present he stops quinine, or gives it very cautiously. It is, however, the irony of fate that many people are averse to take quinine, basing their refusal to do so on the misrepresented authority of the great advocate for that medicine. It is one of those superstitions that die hard, and that do a great deal of harm.

The other objection is founded on the crude misconception that the quinine is intended for the patient to produce some direct effect on him, instead of being, as is the case, only a poison for the malarial parasite. A form of quinine that would have no effect on the patient himself is a great desideratum. Ross thinks that a quarter of a billion parasites may cause an access of fever. A dose of 10 or 15 gr. would, on this basis, supply to each parasite an infinitesimally small quantity of the poison; but there is no reason to suppose that the parasites become accustomed to it.

It should be mentioned that the Italian Government now issues only the bi-sulphate and the hydrochlorate of quinine, the salts they found to be best tolerated, to be cheapest, and most soluble. The sulphate they have discontinued on account of its indigestibility. The ethyl carbonate (euquinine) is too costly for general preventive use. The dose of quinine given by Koch for the cure of actual fever has already been mentioned. He gives it by preference in the morning after some light refreshment, and not during, but about five hours before, an access of fever is expected. Celli gives, as a cure, $1\frac{1}{2}$ gram each day for four days, then 1 gram a day for four more days, followed by $\frac{1}{2}$ gram a day for 15 days. Ross advises 10 gr. every twelve hours for a week. My own treatment of malarial fever in British New Guinea was very successful in many hundreds of cases. It consisted of a dose of 10 gr. of quinine, with 5 gr. of antefebri-ine, once or twice a day.

PREVENTION OF MALARIA BY MECHANICAL MEANS.

We pass on now to the means of mechanical prevention that are so much favoured by Professor Celli and many of his countrymen. It should be stated that quinine is generally given at the same time as a preventive. As might be supposed, the employment of some mechanical protection against the punctures of mosquitos seems to be very ancient. Papuans have used the mosquito net from time immemorial.

You know that a product resembling cheese cloth in texture is attached to the lower edges of the leaf stalk in certain palms. They sew together many pieces of that material to make a mosquito net, which is suspended by a cord attached to the middle part. The Fijians made a mosquito net from cloth beaten out of the bark of the paper mulberry.

Last year my private secretary, Captain Elgee, in looking through my file of science record, came on the translation of a passage in which Herodotus is made to say that the Egyptians used to protect themselves from mosquitos by means of fishing nets. Well, at first sight one could not see very clearly how a fishing net could keep out mosquitos; and one was, to say the least, inclined to doubt the word of this veracious historian. But the other day, when driving along a street in Rome, I noticed that many of the houses had large-meshed nets suspended in the doors to keep out the pertinacious house-fly.

If a net with a mesh an inch square can keep out a fly, there is no reason why a fishing net, which may, indeed, have a smaller mesh than an inch, should not keep out mosquitos. It is only a question of having enough net to let the perpendicular threads or cords touch each other. Since I noticed those nets in Rome, I see no difficulty in believing the statement of the father of profane history. The Egyptian fishing nets, moreover, would furnish a protection analogous to that obtained by many aboriginal peoples by suspending in the doors of their houses large, loose, bundles of grass or fibre so as to keep out winged insects.

In Italy mechanical protection is now generally obtained by means of wire netting, fitted into the doors and windows on suitable wooden frames.

The netting made in America, with fourteen meshes to the inch, is preferred. The wires are of iron, covered with a coating of zinc, over which is brushed a thin layer of varnish, to prevent wet and sea air from reaching the zinc and iron. There is, however, no doubt that salt water speedily attacks zinc. This netting seems to last fairly well, but it has not as yet been long in use.

It is a much cheaper netting than one made of any compound of copper or tin. At Lagos there are rose-houses of varnished wire that has stood the climate well for eight or nine years. Where the netting is required only temporarily, or where means are not available for the purchase of metallic netting, the ordinary cotton mosquito netting may be used. At Lagos we are giving each officer a mosquito-proof room, in which he may sit and dine, or read and write, in safety and without molestation. It is assumed that one will protect oneself in one's bedroom by means of the mosquito net. The peasants and others that use the wire netting in the Agro Romano assured me a few weeks ago that it causes them no trouble. Unfortunately it does, however, cause a good deal of inconvenience near the equator by the way it interferes with ventilation. That, however, is a small matter compared to malarial infection. The one other method of protection of which I had a large experience is smoke. Professor Celli has shown that of all smokes that from tobacco is the most deadly to the mosquito. In New Guinea many houses are built on piles sufficiently high to allow fires to be lighted on the ground below, so as to fill the house above with sufficient smoke to drive out mosquitos. I am afraid that I must admit that I have often fled before the mosquitos did. At other places a whole tribe may live in one house divided into stalls for the accommodation of several hundred people. Each stall has a fire; the doors are all closed and there are no windows, and in this way the house becomes so filled with smoke that no mosquito can live there. In Florence in October last we found our rooms infested by the *Culex*, and in the absence of mosquito nets had to burn every night in each bedroom two or three cones of pyrethrum and saltpetre, known there as "zamperonis." Pyrethrum smoke certainly narcotizes the mosquito and keeps the insect quiet for a few hours; but the zamperonis do not seem to kill it. Unfortunates these cones are apt to cause headache. Naturally they can be used only in places where there is but little circulation of air. It is impossible to overrate the value of the mosquito net, or to deny that the wire netting is of very great service. The latter is also probably cheaper in the long run in many places than any other form of prevention. Celli finds that only about 2 per

cent. of those protected in this way contract primary malarial fever. It will be noticed that at Lagos this form of protection supplies a second line of defence, behind the prevention sought by the systematic use of quinine as a prophylactic. The wire netting is specially useful in such places as the Lagos Hospital. All Europeans suffering from malarial fever are kept in mosquito-proof wards. In a short time this will be extended also to all native cases of fever. This is a great protection to the staff, and goes a long way to preserve the mosquitos of that neighbourhood from becoming infected.

ROSS'S PREVENTIVE METHOD.

Both the medicinal and the mechanical prophylaxis that we have considered are of great importance but in places of permanent abode the system of Ross, which may be regarded as "the thorough" or "radical" method of dealing with malaria must always be put in practice, and must be pushed with patience and determination. It is open, relentless war to the knife against the whole race of mosquitos. We are fast learning that they are all bad, that several of them besides the *Anopheles* are highly dangerous. Koch's method frees the patient from parasites, and thus prevents the mosquito from becoming infected. The wire netting alone would prevent reciprocal infection between man the mosquito. Each of these two systems, or the two combined, would leave alive and well the whole family of mosquitos. Ross's method would exterminate all mosquitos. In principle the Ross system is simplicity itself. The mosquito cannot have her family reared without a suitable breeding ground, which means ponds, puddles, etc. We must not supply new breeding pools to the mosquito, we must deprive her of those she has got, or make them unfit for her progeny. Clearly, where the Ross method is carried out completely, there is an end at once to both medicinal and mechanical prophylaxy. Unfortunately, like the majority of great works, it is in many places not easy of accomplishment, and will be attempted only at populous centres.

It is sometimes objected to this plan that it is impossible to get at and kill all mosquitos. The aim of this system is less ambitious; it is meant to kill out the mosquitos of a neighbourhood, on the understanding that their habits generally restrict them to their own domestic locality. It means, in broad terms: Dry up all freshwater pools and puddles by draining or reclaiming; and if they cannot be drained or filled up with earth or salt water, then put crude petroleum on the surface of the water periodically, at such intervals as will prevent the complete development of a brood of mosquitos from the egg to the insect. A marked feature of this method is the punctilious removal of all empty tins, broken bottles, or of great and small receptacles of any kind in which mosquitos could breed. This part of the system is easy and cheap. But the problem becomes very difficult of solution when, for example, one has to deal with a place like Amsterdam, which is below the level of the sea; with the Agro Romano and its vast areas of marshy land; or with Lagos, which has perhaps a fifth or a sixth part of its area composed of swamps that lie very few feet above sea level.

In Lagos the radical method of Ross is being pursued by filling in the swamps with sand or sandy soil from near the sea beach. This work will, on account of its magnitude, take some years to accomplish. The large pools that cannot be drained at present have crude petroleum put on the surface periodically. Empty tins and similar things are removed. As water for domestic purposes is very generally collected from the roofs of the houses in iron tanks, these latter are being closed up by a cover like the lid of a tin flagon, and the pipes of ingress and egress are covered at the open ends with wire netting.

My own house was formerly a place of torture on account of the worrying and incessant attacks of mosquitos. Strange to say, we found that about 75 per cent. of them were *Anopheles*. The mosquitos were largely reared in flower-pots in the house, and in small cisterns in the grounds. In addition to the removal of these breeding places a mosquito catcher has been appointed, whose sole duty it is to find and kill every mosquito that enters the house. A mosquito catcher costs £1 a month. In a short time he becomes very expert, and is well worth his wages. The mosquito boy should be on the

fixed establishment of every European resident in such a place as Lagos.

The other day I paid a visit to Amsterdam to see what the effect had been on malaria there from filling the greater part of the canals of that city with salt or brackish water from the Zuyder Zee. It seems that the water of those canals contains not less than 2 or $2\frac{1}{2}$ of salt to 1,000 of water, and that the *Anopheles* mosquitos do not breed there in water of that degree of salinity.

A few days I was assured by Dr. Schoo, of Krommonie, that he and Dr. Ringeling, Sanitary Director of Amsterdam, have completely failed, after many trials, to find larvae in these canals. But larvae are plentiful in the parks and gardens on the periphery of the city, where there is fresh water both in the canals and in swamps and ponds. It is hoped that it may be found possible to utilize this knowledge to a larger extent in a low-lying place like Lagos, and to combine it with reclamation in dealing with some of the swamps in that place.

At the same time I must tell you that though these observations of Dr. Schoo are in harmony with the results of similar researches in Italy, yet Major Ross and myself found swarms of larvae in Egypt in water of a higher degree of salinity. But this point we can study at Lagos by direct experiment without much trouble, and ascertain there the highest grade of salinity in which larvae can live in that climate. A great system of covered drains at Lagos would not be possible without permanent pumping on a large scale, and therefore our swamps cannot be dried in that way.

In connexion with Ross's radical method of prevention, reference should be made to a very important question that is certain to come before some of you sooner or later. It is that of the segregation of Europeans from natives. I understand that the general academic view is that they should occupy separate and distinct quarters. I make no attempt to put these separatist principles in practice, because to my mind they are impolitic and unscientific. In a place like Lagos it would be most unwise to introduce any racial distinction of that kind. It is clearly our duty, if we can improve our own position with regard to malaria, to improve the position of the natives of the country at the same time. It would be surely highly unscientific to leave alone as a permanent prey to malaria, as perennial centres of infection to one another as well as to Europeans. To carry the idea of segregation to a logical conclusion, the Governor of Lagos would have to take shelter in a mosquito net when he receives the chiefs of the country; and when he sits in church immediately behind a choir of two or three score of native boys, he would have to occupy a glass case or a wire cage. The only sound way to proceed in this matter is to advance ourselves, and take the natives along with us. We cannot possibly avoid contact with them. It is therefore better that we should not try to do so. If we fear infection from them, then we can protect ourselves by curing them. That is the only way of meeting this difficulty so as to fit it in with the thorough system of Ross on the one hand, and with our clear and simple duty towards the native on the other hand.

BLACKWATER FEVER.

It is hardly possible to avoid here a brief notice of the much-feared blackwater fever. As already mentioned, it seems to be now and then connected with the irregular administration of heroic doses of quinine. That it may occur without any such inciting cause I have had experience in my own person, for I had not tasted quinine for many months before I had my one attack. Unfortunately, the nature and treatment of this malady remain still in an undetermined condition. Some authorities seem to think it is not really of malarial origin. I may state my own views briefly. I served first in the Seychelles Islands. There we had no malaria, no blackwater; then in Mauritius, where we had malaria and blackwater; then in Fiji, where there was neither malaria nor blackwater. My next abode was British New Guinea, with malaria and blackwater; and my present residence is Lagos, where again we have both. Naturally, therefore, I incline to the opinion that blackwater is malarial; and I shall very likely lean to that view till I know of some place where blackwater occurs without malaria. Formerly it was common in Holland, but now the only malarial

fever there is mild tertian. According to Dr. Schoo, the population of Holland was, in 1886, 4,336,072, with 103,046 deaths, of which 306 were from malaria and 136 from perniciousa.

In Italy it is not met with, or is uncommon, in the higher situated tertian areas. In places like Lagos, where the aestivo-autumnal type is common and endemic, it is far from rare. There is no fixed treatment. The most successful known to me is that introduced by Dr. Gouzien, late Chief Medical Officer for Dahomey, for an account of which I am indebted to M. le Docteur Kermorgant, Inspecteur-Général de Santé des Colonies Françaises.

This consists essentially in the subcutaneous injection of a standard saline solution, 7 grams of sea salt to 1,000 of water. In mild cases from 4 to 6 enemata, each of 200 grams of this solution, may be given in 24 hours. If this does not succeed, then the more rapid and efficacious subcutaneous injections are employed, each of from 100 to 300 grams. They are practised in the hypogastric region. The rule is to give one of these a day. They have never required more than four in any one case. Dr. Gouzien administers at the same time a native remedy, an infusion from the leaves of *Cassia occidentalis*, 15 grams of the leaves to 1,000 of sweetened water, of which from 1 to 3 litres a day may be given.

The records of the Sanitary Department of Dahomey show that fifty-three successive cases were cured by this treatment. It is painful, but certainly seems efficacious.

It appears that Dr. Strachan, Chief Medical Officer of Lagos, suggested, some years ago, the use of saline enemata in the treatment of blackwater. Salicylate of soda seems to be given for this disease in some parts of West Africa. In New Guinea the treatment was always small doses of quinine and anti-febrine, with nitrate of potassium and other diuretics. It was as successful as any treatment known to me with the exception of the subcutaneous saline injections of Dr. Gouzien. It should be added that Dr. O'Sullivan-Beare has cured five cases by a native remedy of the East Coast, a decoction from the root of a small tree, the *Cassia bearana*. Each of these native cassia remedies should be carefully investigated.

In extreme cases one would think that intravenous injection of a saline solution should be tried; and if there has been great destruction of the red corpuscles, one cannot but believe that recourse should be had to the transfusion of blood, as used to be so frequently practised for other ailments some years ago in Australia. It may well be that transfusion of blood has been tried in grave cases of blackwater fever, but I have not heard of such treatment.

EDUCATION IN MALARIA AND SANITATION.

Finally, I should like to say that in the great struggle with malaria, I attach much importance to the education not only of the people that live in malarious countries, but also to those of us that remain at home in these islands. This idea was put in practice at Lagos in the first instance by a course of lectures, having special reference to malaria, by Dr. Best, Resident Surgeon at Lagos Hospital.

Then a more comprehensive and elaborate course was given by Dr. Henry Strachan, C.M.G., Chief Medical Officer of the Colony. The teachers of the primary schools receiving money grants from the Government were invited to attend that course. They were examined at the end of it, and given, where they deserved it, first and second-class certificates that they are competent to teach sanitation in the primary schools.

Formerly the distribution of the Government grants was determined by the results obtained in reading, writing, and arithmetic. To these three is now added a fourth, sanitation.

In putting this into practice I have had much assistance from the Chief Medical Officer. Lectures on malaria were also delivered at some of the country stations. The necessary apparatus for courses of illustrated lectures by medical officers in all the great towns of Lagos territory, is now being prepared for me by Major Ross. Many hundred printed copies of the lectures by Drs. Strachan and Best have been distributed gratuitously. They have even been reproduced in this country. In addition to this, the most useful reports by Koch, Celli, and others have been translated and printed in the Lagos Government *Gazette* for public distribution. Ministers preach on sanitation; and we have a most influential Board of Health. It was stated recently in the public

press of this country that at a congress of sanitary inspectors one gentleman had suggested that sanitation should be taught in the primary schools of England. Doubtless he was unaware that the School Board of Lagos has solved that problem. A few days ago it was stated at a congress on infantile mortality held at Essex that the death-rate among children at Barking is, during certain months, over 40 per cent. Does that not show that there are in this country many people other than children that require to begin their sanitary education?

Personally, I believe that to make our work in sanitation progressive and permanent in Lagos, it is absolutely necessary to educate the natives of the country in sanitary matters.

Then again, I have at the present time a very direct interest in the question of sanitary education in this country, because I have been trying to form a great malarial trust for Lagos, which is to comprise all the missions engaged there, and all the merchants living in this country that have establishments in that Colony. With co-operation and assistance from these quarters, the Government can do much more than it could possibly do working alone. The most willing and hearty co-operation has been promised from the Roman Catholic Mission, from the Church Missionary Society, from the Wesleyans, and from the merchants of Liverpool. I look with confidence to the merchants of Manchester, whom I have not yet visited, for similar co-operation. We want assistance and encouragement from a still greater public, for all alike have a responsibility in this matter.

Whilst on the question of education I should mention to you an objection with which I am often met, and which generally takes this form:—"But I am not convinced that malaria may not be communicated to man in other ways than by the puncture of the mosquito."

Gentlemen, we do know with absolute certainty that appalling numbers of people are inoculated with malaria by the mosquito, and thus lose their health or their life. We do not know that malaria is communicated in any other way. Once I was approaching the coast of New Guinea in a steamer lent me by the Government of Queensland. Without a moment's warning we touched some coral, and in an instant had a stream of water pouring upon us through a large leak. We did not sit down to debate the problematical possibility of there being a small leak somewhere of which we knew nothing, but we promptly pumped water out to keep ourselves afloat, and we tried to stop the leak we saw. We know that the mosquito opens a leak through which death rushes on hundreds of thousands of ourselves and our fellow subjects. I say, therefore, that it is our duty to try at once to close that great leak, and not to waste time in first looking for possible smaller ones. Indeed one would, *a priori*, be inclined to think that as the changes in the cycle of Ross are so pronouncedly specialized, the probabilities are strong that malaria is produced in man only by the puncture of an infected *Anopheles*, a view that would be favoured by the analogy of certain other diseases well known to you, that are communicated only by a special host or intermediary. At the same time we must not forget that malaria can be inoculated directly from one man to another, a fact that of itself should restrain us from pronouncing at present an absolute dictum as to the *Anopheles* being always the only one channel of infection.

From what has been stated it will have been gathered that at Lagos we attack malaria at all points in all the several ways and methods that have been mentioned here to-day. European and native alike begin to take an interest in the subject, and to understand something both of the nature of the malady and of the great importance of bringing it under control.

We believe that we have already brought about considerable amelioration, and our experience tends to steadily confirm us in the conviction that we are proceeding on the right lines. For my own humble part I confidently expect to see scepticism disappear in respect of malaria as it did in regard to antiseptic surgery.

Gentlemen, I thank you for having honoured me with your presence here to-day, and I wish to express my deep obligation to one of the greatest of my teachers for having allowed me to meet you in this manner.

REPORT OF A CASE OF BILHARZIA FROM THE WEST INDIES.

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WITH the exception of Mesopotamia, Cyprus, and Mauritius, bilharzia disease has hitherto been supposed to be peculiar to Africa. The following case shows that the parasite has a wider range. Personally, until I came across this case, I never encountered the disease in patients from the West Indies, but its occurrence in a white man from that part of the world practically proves that in some of these islands, if not in all, it must be by no means uncommon amongst the coloured population. Now that attention has been directed to the subject, we may expect to hear from time to time of similar cases. It is evident that the distribution of this and similar parasitic diseases depends on the presence or absence of the efficient intermediaries. Possibly our zoologists may be able to point to some mollusc or anthropolod which the West Indies and Africa have in common, and thereby indicate the long-sought-for, but hitherto undiscovered, intermediate host of bilharzia haematobia. Another African disease, guinea-worm, was at one time said to be endemic in Curaçao and others of the West India Islands, and in a limited area in Brazil. I understand the disease has disappeared from Curaçao, and we hear no longer of its presence in the Brazils; it may be that bilharzia has obtained a similar precarious footing in the Western Hemisphere, and that subsequently it will disappear from that region; meanwhile we can assert its presence there as a fact.

I may mention that the patient, an Englishman and a professional man, came to me as a private case complaining of vague symptoms, lumbar pain, headache, etc. As I could not account for the symptoms, and as he looked anaemic, and knowing that he came from a place where ankylostoma duodenale is very prevalent, the idea that he suffered from ankylostomiasis occurred to me. I made an examination of his faeces and discovered the ova of bilharzia. In this case, as so often happens in bilharzia ova from the alimentary canal, the spine is placed laterally.

I am indebted for the following notes to Major Ross and Dr. Daniels, of the London School of Tropical Medicine.

Previous History.—The patient is an Englishman aged 38. Five years ago, in Antigua, after a heavy day's work he felt a dull pain in the lumbar region; it went off after rest, but would come on again after active exercise. During the last year this pain has increased in severity and duration; he was invalided home on account of it. Has resided in the West Indies chiefly for fifteen years, and has had many attacks of malaria. Never passed blood in his urine; never noticed blood in his stools.

Present State.—Temperature 97°; tongue slightly coated; is slightly anaemic; complains of right frontal headache; has some enlargement of liver and spleen.

Microscopic Examination.—Faeces, bilharzia ova not numerous; generally distributed throughout the faecal mass; lateral spined. Urine, no ova.

Blood (By G. Duncan Whyte).—Haemoglobin, 84 per cent.; red blood cells, 4,650,000; white blood corpuscles, 8,200; polymorphonuclear leucocytes, 49 per cent.; lymphocytes, 21 per cent.; mononuclear leucocytes, 17 per cent.; eosinophiles, 12 per cent.; intermediate, 1 per cent.

History of Patient's Residence in West Indies, by Himself.—I went from England to Antigua in May, 1887. In the place I lived in there are a good number of swamps, but my house was a mile from the nearest; water was obtained from cisterns (iron) and ponds, was often stale, and contained visible living things; had two or three attacks of malarial fever, one severe.

I removed to Anguilla in 1889. It is a flat and dry island. The drinking water came from stone cisterns, the bath water from wells. My health here was fairly good.

Moved to St. Kitts in 1891. This is a mountainous island, no swamps within six miles of my residence; water from public service reservoir conveyed in pipes. My health was fair, but had two or three "run-downs" and one or two attacks of fever. Came to England in June, 1894, and returned to St. Kitts in January, 1895.