A MEDICAL AND SANITARY SURVEY OF MAURITIUS: PAST, PRESENT AND FUTURE.

BY

ANDREW BALFOUR, C.B., C.M.G., M.D.,

Director-in-Chief, Wellcome Bureau of Scientific Research.

I have so many lantern slides to show that I do not intend to read any of the notes which you have already in your hands. The Government of Mauritius reported some time ago that the medical and sanitary conditions there were exceedingly bad, in fact worse than in any other British Dependency. As a result, the Colonial Office decided to send someone out to report on the question, and the lot happened to fall on me. My duties were to investigate, in the short period of six months, the whole conditions, medical and sanitary; to plan a scheme for the reorganisation of the Medical and Health Department, which had fallen into disrepute; and to advise as regards the allocation of a large sum, amounting to nearly a million sterling, which had been raised as a levy on sugar through the efforts of the Governor, Sir HESKETH BELL, for the purpose of carrying into effect necessary reforms and improvements.

I might begin with three famous words of Lord Macaulay, "Every schoolboy knows," and continue, where Mauritius is situated. I can only say that were I to do so I would be guilty of a misstatement. I have two sons—both schoolboys—and I found that neither of them had the vaguest idea as to what part of the world their father was proceeding. Furthermore, in the Municipal Chambers, Port Louis, one of the most treasured exhibits is an envelope which once contained a letter from Buckingham Palace, and which bears the legend, "Mauritius, West Indies." It is also true that a distinguished military officer accepted an appointment in Mauritius, believing it was in the West Indies, and was annoyed to find himself 600 odd miles east of Madagascar!

I would not insult any Fellow of this Society by suggesting for a moment that he was not fully conversant with the geographical position of one of our more venerable colonies, but as memories are apt to be defective it may be well to furnish a few details regarding it.

Mauritius then is an island shaped like an oyster shell, and situated in the Indian Ocean between latitude $19^{\circ}50'$ and $20^{\circ}31'$ south and longitude $57^{\circ}18'$ and $57^{\circ}48'$ east of Greenwich. It is thus just within the tropic belt, but, owing to its southerly situation, its immediate surroundings and the influence of the Trade Winds, it by no means conforms to the customary idea of a tropical island. It is nearly 39 miles long and its greatest breadth is 29 miles. Its area closely corresponds to that of Surrey, being 716 square miles, while that of the home county is 758. Moreover, some parts of the island, notably Curepipe and Vacoas, towards the summit of the central plateau, recall in some measure certain features in the scenery of Surrey, and make it hard for the visitor to realise that he is in the southern tropics, many thousands of miles from the heights of Hindhead or the fir-bordered roads of the Farnham district.

So varied is the scenery, so bold are the mountain ranges, so large some of the rivers, that it is difficult to appreciate the fact that one is on a small island. It suggests a continent in miniature, yet it is impossible to go far in any direction without a view of the ocean, that glorious sapphire sea which circles the colony, and whose great breakers beat ceaselessly upon its coral reefs.

In a way Mauritius resembles some of the West Indian islands, yet it is a likeness with a difference, and I am not sure but that the difference is in favour of the old Isle de France, for it is a very lovely and attractive place and possesses advantages unknown in the Western Indies. Certainly, it is more favoured in the way of climate. The latter is mild and equable. According to the *Mauritius Almanac*—that storehouse of information annually compiled with great pains and much labour by Mr. Walter, the learned and energetic Director of the Observatory—the maximum shade temperature recorded at the Observatory, which is situated in the district of Pamplemousses, 178 feet above sea-level, has never exceeded 95°F. , while in the highlands, as for example at the residential capital, Curepipe, 1,800 feet above the sea, it rarely reaches 80°F.

The relative humidity is high and hence during the summer the heat

is at times oppressive, especially in the lowlands and more particularly in the capital, Port Louis, shut in as the latter is by an encircling belt of hills.

The only taste of the hot weather I experienced was during the month of April, and at that period Port Louis was unpleasant, though not unduly so. April, however, is not the worst month of the year.

From May to the end of September the climate is delightful, though a trifle cold and damp in the loftier parts of the highlands. Curepipe indeed is a very rainy place, so much so that its inhabitants are suspected of having webbed feet! Owing to the high relative humidity it is sometimes disagreeable in the cold weather, though the temperature never and nowhere falls below 44·6°F.

The rainfall varies a good deal in different parts of Mauritius, the mean annual fall ranging from below 29·9 inches on the north and west to 150·9 inches on the central plateau, where in years of maximum rainfall it exceeds 196·8 inches. Rain falls practically all the year round in the higher parts of the island. A distinct wet and dry season can only be differentiated in the coastal regions but, speaking generally, it may be said the rainy season begins in December, reaches a maximum in March and gradually decreases till June. There is a second maximum in August. The dry season occurs in October and November. During cyclonic disturbances, which are not uncommon, torrential rains may fall, a point of importance in connection with anti-malarial works. The physiographical features of the island will be pointed out on the screen. Here I would only say that Mauritius is of volcanic origin and its rocks are thus basaltic, consisting largely of trap, trachyte, and lavas. Some of the lavas are highly porous, and two varieties can be distinguished, *i.e.*, those containing large cavities and those with small pores filled with calcareous infiltrations.

This possibly has an important bearing on health conditions for, in many parts, the ground dries after rain with remarkable rapidity. Hence there are localities where surface water does not remain for any length of time, while outdoor recreation can be taken soon after heavy showers, a matter of considerable hygienic importance.

FOWLER, in his excellent *Malarial Investigations in Mauritius*, 1908, distinguishes the following five varieties of soil from which it will be

seen that, as indicated, the above-mentioned condition is by no means universal :—

“(1) The loam variety, which is most common. This is porous and allows water to drain rapidly through it. It contains few springs. This is a healthy soil.

“(2) The red soil, coloured with iron oxide, a loose gravel mixed with clay. Underlying it are often found beds of pure clay, consequently water is liable to collect and stagnate in it. This soil bears an evil reputation as regards malaria. “Terre rouge” and “la fièvre” being almost coincident terms in the season.

“(3) The black clay, extending from a few inches to three feet in depth. A considerable part of Port Louis is built on this, and many other districts, where fever is very prevalent, are composed of the same.

“(4) Sheets of rock, evidently the remains of laval outflow, bare or covered with a shallow top-soil.

“(5) Sandy soil, chiefly along the coast. When mixed with disintegrated coral and decaying vegetable organic matter or rotting seaweed, it has originated outbreaks of several fever epidemics amongst the troops.”

As is sometimes forgotten, it is essential to consider soil, sub-soil and deep-lying strata when discussing the effects of telluric conditions on the public health, at least in tropical countries where malaria is rife.

Pictures illustrative of malaria and anti-malarial work form perhaps the most important part of my lantern demonstration, hence it seems only fitting that attention should be directed to the historical aspect of the question, especially as malaria has played a very remarkable rôle in the recent annals of the island.

The work of Ross and FOWLER is so well known that there is no need for me to recount how, possibly, the accidental introduction of *Anopheles costalis* into Mauritius, apparently somewhere about 1865, was the cause of a terrible outbreak of the disease. In Port Louis, out of a population of 80,000, 22,231 perished in the short space of thirteen months. Ever since that time malaria has had to be reckoned with in the colony. It has caused the loss of many lives and much treasure, and I firmly believe if Mauritius had not possessed in many parts so porous a soil and been blessed with such a remarkable winter climate it might

easily have been ruined, as was ancient Greece, and as were large tracts of ancient Italy and Spain.

Mauritian doctors have studied and fought the fever; Mauritian entomologists have dealt with its vector; Ross has produced a classic on the subject, and, I am glad to say, conditions have greatly changed for the better.

I am of opinion that still greater changes can be produced, and that, even if the disease and its carrier cannot be utterly stamped out, they can both be so greatly reduced as to be almost negligible. I think and hope we stand at the commencement of a new era, where increased knowledge, sound administration, concerted action, and, above all, ample funds will in a few years revolutionise the situation.

Hence it seems well to look backward for a short space and realise what malaria meant, when, like a pestilence, it ravaged this island of the sea and when 234 people died of the fever in one day in the capital.

In the course of my reading I find the best and most graphic description of the great epidemic, which slew in all 31,920 persons, is to be found in a work bearing the curious title, *Sub-tropical Rambles in the Land of the Aphanapteryx*. This interesting book, which gives a good account of Mauritius in the late sixties of last century, was written by Colonel NICHOLAS PIKE, who was not only American Consul at Port Louis but was an ardent zoologist. Here is what he, as an eye-witness, recorded:—

“Those who inhabited Port Louis during the terrible mortality in 1867 and 1868 will never forget the sad spectacles the city presented daily. Fever! fever! was the only word on every lip, the only thought in every heart. Mourning and desolation everywhere. Scarcely a person visible that did not wear the garb of woe. Song and laughter had ceased.

“Port Louis was once remarkable for the number of pianos heard in every street in an evening, from the Erard's grand and semi-grand to the humblest cottage instrument.

“At this time it was literally ‘The daughters of music were brought low, and the voice of mourning was heard in the streets.’

“Funeral trains were met at every corner. Relays of men were kept night and day digging the graves.

“The owners of undertakers' shops that sold mourning, and the

apothecaries, must have made fortunes. The numerous druggists' shops were so crowded day and night, and so short of hands, that it was with difficulty medicine could be procured. Offices were opened in all directions for the distribution of food, medicine, or advice to the destitute; but all the efforts made by the municipality and private charities could not keep pace with the strident progress of the wretchedness and distress.

"There was no mistaking the appearance of one who had suffered: the pallid, drawn features, the skeleton, bloodless fingers, as if the bright life-stream had been dried out of them, and the slow dragging step marked but too plainly the victims.

"It was distressing to pass through the streets: in every corner was some poor creature, suddenly struck down, and crouching on the ground to die.

"In the outskirts of the city and country roads the victims were so numerous that the police and sanitary committees were insufficient to succour half the poor wretches, and many died by the roadsides before help could be brought to them.

"Near Roche Bois I have seen them lying in groups, dying and dead. Not a house, within a radius of half a mile from the one I then occupied, had a living person in it, except at a shop belonging to three Chinamen, two of whom died later.

"In many cases, as soon as a Malabar got the fever, he would hasten to his house and shut himself in to die; for such was the fear of it, to be attacked was the tocsin of death to him.

"I visited many families, and the scenes I witnessed will never be effaced from my memory. A poor Indian, whom I had cured for the time being, came and entreated for help to a comrade. It was night, and I was tired and had gone to bed; but the poor fellow begged so hard that I dressed and went with him. After a long walk we came to a hut, and as I approached I heard groans and lamentations. When I entered the scene baffled all description. A small cocoa-nut oil lamp dimly lighted the interior, adding horror to the scene.

"It was inhabited by a man and his wife, with a number of children. The mother lay dead in the middle of the hut, the man hanging over her in an agony of grief. Her baby, still living, was clasped to her heart,

and seeking to draw its life-sustenance from her cold breast. The other children were all stricken with the fever, and in its last stages, past human help. Of course all I could I did, but help had come too late to do little more than assist in their burial.

“One dreaded to ask the news, as one was quite sure to hear of some friend ill, dying or dead, and often buried before you knew of it. Parents had to rise from their sick beds to nurse their children, and these again had to drag their weary limbs to follow a beloved parent to the tomb, though frequently too weak even to do that.

“No change of weather seemed to arrest the plague. Intense heat or cold, heavy rains or dry, mild calm days, or sharp breezes, all were alike fatal. The brightest morn brought no more hope than the wildest night.

“For months the death-rate in the city alone averaged nearly 200 *per diem*. In every street could be seen the mourning weeds outside the doors where death had struck his victim and this was often the first intelligence you had of the loss of dear friends—no time for ceremony then. May I never witness again the sad sight of those incessant funerals, slowly wending along from morn till night.

“Here a group of Malabars bearing along some poor fellow, preceded by a priest muttering a prayer, and followed by a few women bearing a copper dish of rice and fruit, and a jug of water, to place on his grave.

“There comes a slow and stately train with black-plumed hearse, and a long line of carriages behind it—one of the rich and respected of the land; anon, a little simple bier, bearing a baby’s coffin covered with a simple white muslin pall and wreath, with perhaps only the father and nurse as mourners; then a white-covered hearse, its white plumes and the horses’ sweeping trappings showing that some fair girl had been cut off in early womanhood.

“Occasionally would pass a Chinese funeral, the bier supported by stout Malagash bearers, in their long black gowns and flowing weepers looking as stolid as if of stone; a few carriages following with Chinamen in them, and a person always preceding it, scattering pieces of paper about three inches square, often gilt or silvered, all along the road, to scare away evil spirits and prevent their following the corpse to its last resting place.

LINES ON THE CEMETERY AT BOIS MARCHAND.

They lie in thousands side by side,
 On that wild desert plain ;
 The loved, the cherished, nameless there,
 By raging fever slain.

In tombs of their ancestral dead
 Their bones may never lie ;
 No marble records shield their graves
 Beneath that torrid sky.

O'er that blent mass of human clay
 No mourners bend in tears ;
 No wreaths, no votive offerings there,
 Though the loss will be felt for years.

For there the grey-haired grandsire lies,
 With the darlings he loved so well ;
 And there the bride of a few short hours—
 Of such griefs what tongue may tell ?

The mother with her first-born babe,
 The father in manhood's pride ;
 The fairest and best were swept away—
 Our friends so trusted and tried.

Long, long will the "Gem of the Ocean" rue
 The fever fiend's deadly rage ;
 For sadder sights than its shores have seen
 Rest not in History's page."

Let us hope he was a better naturalist than he was a poet. The verses which I have read to you do greater credit to his heart than to his head, for neither his scansion nor his imagery is above criticism. Still they must have a place in the literature of malaria.

I found his succeeding remarks on the etiology of the disease so curious and interesting that I have transcribed them. Remember he was working in the dark and that he was not a medical man. In any case the medical men of the period had very similar views and the authority he quotes in support of his argument was, I believe, a doctor. Thanks to LAVERAN, MANSON, ROSS, GRASSI and many others, we know better nowadays and can explain, for example, why people living near marshes at a high altitude, such as Mare aux Vacoas and Bassin Blanc, escaped the fever.

"Everywhere one heard the questions, 'What have been the pre-disposing causes of the epidemic ? and what are the existing causes of its long continuance ?'

"Whatever may be the difference in opinion as to the origin and modes of propagation, all agree that certain states of the air favour the

disposition of the body to receive intermittent and remittent fevers, and rivet them into the constitution, which baffle all attempts at complete cure, and induce a tendency to relapse from apparently slight causes.

“The concurrence of cold with a moist atmosphere; heavy rains after long dry weather; weakness of body, whether owing to poor and unwholesome diet, fatigue, severe evacuations, or previous diseases; anxiety of mind; inactivity, intemperance, or restlessness, all increase susceptibility; while hope, confidence, cheerfulness, whatever can excite mental energy, lessen it.

“Differing as intermittent and remittent fevers do in many points, particularly in their rate of mortality, they yet agree in their origin as occasioned by effluvia emanating from putrid, stagnant waters, swampy low grounds, and animal matter. It is found in the tropics that malarious diseases are most common in the seasons succeeding heavy rains, when the temperature is high, and where the surrounding country abounds with jungles, and insect life is rife.

“It is now well ascertained that gases, emanating from decomposed vegetable and animal matter, generate confervaceous as well as diatomaceous plants, such as *Tetraspora nostoc* and all the genera *Agaria*.

“These cryptogams are never found in *dry* warm situations, but where it is *damp* and warm, and they develop themselves especially where organic matter is in a state of putrefaction.

“Some of these plants live on the surface of stagnant waters, but very many on the surface of low lands. Others are parasites on plants, which they destroy, as is shown in the diseases of the vine and potato.

“In *Oidium tuckeri* the spores are so small that EHRENBURG, the great microscopist, was scarcely able to detect the form of a thousand of them, grouped together, with the highest power of the microscope. Our knowledge of the elementary structure of organisms is exclusively based on microscopic discoveries, and modern physiology is the result. Organic chemistry has materially participated in the development, but the microscope excels the chemical re-agents in practical usefulness, both as to precision and facility, and has firmly established its superiority in histology and physiology.

“Through the medium of these fundamental branches it has benefited medical science at large, and of late has lent material aid as well to diagnosis.

“Sometimes it may delude and give rise to erroneous inferences, but the chances are in such a case it is the performer or an imperfect instrument that is at fault.

“It more frequently reveals the true state of elementary structure and its deviation from the normal state, and thus aids as well as corrects pathological knowledge.

“In a long-continued series of observations, in cases of persons who have died of fever, when particular organs and their secretions were submitted to minute microscopic examination, it was almost invariably found that the membrane lining the stomach was covered with a multitude of very minute plants, closely resembling the Alga, *Cryptococcus cerevisiæ*. These parasites often covered the whole intestinal tract; some were perceptible on the surface of the lungs, and some could be detected in the blood. In the latter, it sometimes happened that there were epithelial cells, apparently containing fatty and pigment molecules.

“On living patients, in the advanced stage of the fever, they may be detected, by one well acquainted with the microscope, in the substance which is formed at the corners of the mouth and eyes.

“Some of the parasites appear quite hollow, others contain nuclei and spores, and others show cell articulations.

“In the secretions of entirely healthy persons they cannot be detected.

“Water taken up in well-cleaned basins out of some isolated pools at Grand River, or where its waters mingle with the sea, and subjected to the rays of the sun till stagnant, developed a green superficial film. Under the microscope this film showed plants so nearly related in shape and structure to those in and on the different organs of the human body, that there is no doubt of their being of the same genera, and it is equally certain that they were exciting causes of the epidemic.

“Myriads of these plants were generated all over the island; and when matured, the spores became free, and were taken up by the wind and carried from place to place. These spores were thus inhaled, and if the stomach was not in a morbid condition, they would pass out without effecting or undergoing any change, or be destroyed by the gastric juices; if, on the contrary, it contained material highly susceptible of fermentation (which the universal rice and vegetable diet here tends to), the spores would germinate and grow, produce inflammation, and fever readily ensued.

“Unlike phanerogamous plants, which absorb carbonic acid gas, depositing the carbon in the plant, and throwing off the oxygen into the atmosphere, all the lower class of cryptogams absorb oxygen, and consequently give out carbon, thus vitiating the atmosphere we breathe.

“It may not be out of place to mention here that the physiological effects of the cinchona bark, and its alkaloids, on vegetables, animals and men, should be borne in mind, as the connection of these effects with the therapeutical influence of the bark in fever was until lately inexplicable.

“DECONDOLLE states that leaves of plants immersed in an infusion of pale bark were dried in twenty-four hours; and others, plunged into a solution of quinia water, presented evidences of contraction in from six to eight hours.

“It is evident, therefore, why this remedy, when used in malarious fevers, acts so beneficially. By this contraction, or process of withering, it destroys the fast growth of the poisonous fungoids in the system, and, if there is no complication, eradicates the disease.

“This fever is only contagious under certain circumstances. Knowing how it is germinated, it will be readily perceived that when a person is attacked with it, in damp unventilated places, it follows as a matter of course, that from the moment the spores in or on the patient become free, all the inmates of the same place, and especially when they are crowded together and filthy in their habits, will be subjected to the disease; and in so far only is it communicable.

“Since writing the above, I met with an interesting article on ‘The Causes of Ague,’ and as it bore so forcibly on what I had written, I transcribe some of its paragraphs at length.

“‘The fertile source of desolation and disease consists of incalculable myriads of microscopic cells, suspended in the atmosphere over waste, marshy, and fen districts. They are minute oblong cells, single or aggregate, and having a distinct nucleus, with a clear interspace, apparently empty, between it and the cell wall. They are of the algoid type, strongly resembling the *Palmella*, and are consequently amongst the very lowest organisms known. Sometimes several of these cells or spores are contained in an outer cell or wall, or delicate investing membrane, to form a plant.

“‘Of these “ague plants” is formed the greyish film wherever damp, black earth is turned up and exposed to the sun. These spores or minute

seeds (germinating cells) rise into the air, carrying pestilence with them. There are several species of the "ague plant," which have been called *Gemiasma*, from the Greek for earth, and the word *miasma*. The white, and a yellowish-green variety, occur usually in a non-calcareous soil, and produce agues of but slight intensity, and are the only ones known in England. There are also red, green, and lead-coloured "ague plants," and one singular species, the "*Gemiasma protuberosa*," which has larger spores, "and consists of groups of jelly-like protuberances."

"These latter kind habitually occur in rich calcareous soils, and produce fevers of a dangerous and congestive character.

"The cells with their spores produce visible incrustations of mould on the surface of recently exposed marsh earth. The danger from these growths is greatest in a hot dry season following a wet one. The wetter and hotter, the worse for man, and the better for malaria.

"The marsh demon is verily "the pestilence that walketh in darkness." It seems almost certain that the spores of the "ague plant" only rise with the evening dews. Microscopically tested, the day air is free from those organisms.

"In different parts of the world these cryptogamic spores rise in the night mists to definite heights.

"In the United States they seldom rise more than from thirty-five to sixty-five feet above the low levels; in England not more than from fifteen to thirty feet.

"These spores are found throughout these vapours, but do not extend beyond them, and are found in the greatest abundance in their upper strata.

"Intermittent or ague fever has actually been produced in men by causing them to inhale the spores of these algæ.

"It has long been known that malaria is movable by the wind, the spores of the "ague plants" having risen and become entangled in the mist; spores, mist and all are blown along together, far perhaps from the place of germination.

"This fact admits of considerable practical application in tropical climates, where the wind usually blows for a long time from the same quarter. It is easy to see how a volume of vapour or fog, laden with its deadly burden of poison-cells, may roll up and hang suspended on the side of a hill, towards which a wind blows across an adjacent marsh.

“ ‘Instances have occurred where the poisonous vapour has been blown over a hill, and deposited on the other side, to the unmitigated disgust of the inhabitants, who imagined themselves secure from their pestilential neighbour.’

“ The above article applies particularly to Mauritius, as I shall endeavour to show by a slight description of the numerous hot beds of the ‘ague plants’ with which the island abounds at the present day.

“ I will begin with the very focus of malaria, Port Louis, and mention a few of the numerous causes of infection in that city alone.

“ The foul streams flowing through it in all directions are, two-thirds of the year, almost stagnant ; the other third they are swollen by the torrential rains, and bear along masses of vegetable and animal matter from the hills and Indian camps, which, as the waters subside, lie festering in the sun, poisoning the atmosphere.

“ The emanations from the open drains, the imperfect drainage of the houses, and the defective method of disinfecting the night-soil, load the air with mephitic vapours.

“ The gradual filling-up of the east end of the harbour from the mud constantly pouring into it, and the tide not being strong enough to wash away the impurities that lodge in the muddy bottom, adds its quota to the malaria.

“ The low shores to the west of the city are only covered at high tides, and are strewn with decayed sea-weed and filth, washed in from the shipping.

“ Between Port Louis and Port William lies a swamp, that receives into its rank vegetation the streams that flow from the cemeteries and another swampy land at the back of them. These cemeteries contain in themselves a very sufficient cause of malaria. The emanations from them are at times most deadly, owing to the circumstances that the dead are not interred deeply enough, and the loose earth and coral which cover them permit the escape of the gases evolved by their decomposition.

“ It has been frequently remarked that the health of the city has invariably suffered from the miasma from its western side that has been blown over it.

“ Between Port Louis and Grand River are low lands, prolific in the germs of malaria. After heavy rain the Grand River swells, and receives

into its floods filth of every kind, which is swept down, or deposited all over its course, or left in pools to decompose in the sun.

“ Near its entrance to the sea, where the waste water spreads out all over the wide embouchure made by the torrents of ages, and the rapidity of the flood abates, it has not power to sweep away all the débris, and part always remains filling up its channel, and impeding its proper egress to the ocean. The whole of this district, and the neighbouring one of Petite Rivière, lie low.

“ Just before the fever broke out at Petite Rivière, there was a large camp of Indians located there, reeking with indescribable filth. The huts crowded to excess, men and beasts herded together ; and with the ordinary dirty habits of the men, and the scarcity of water in that district during the severe drought at the end of 1866, the wonder is the fever left any of them alive.

“ Very few indeed were spared ; and it is a melancholy sight, at the end of 1867, to pass by the camp. Here and there you meet a poor squalid wretch, and a few weakly children ; but nearly all the huts were destroyed that had contained whole families, now swept away, and the few that remained, shut up—it looked like a city of the dead, after teeming with busy noisy life as it did some months previously.

“ The ill effects of allowing the Indians to wash their clothes and bathe in the running streams, thus polluting the waters in their whole course, were well shown during the epidemic, as death with unceasing energy stalked amongst those who lived near such waters, and used them unfiltered.

“ The marshes of Pamplémousses and the West Savanne ; the moist lowlands of Petite Savanne ; the shallow tidal lagoons west of Black River ; and all the low coast-line receiving the drainage from the central watershed, gave out their poisonous exhalations.

“ During 1867 some parts of the island entirely escaped ; most probably lying above the spore level, or fever line, which I see Dr. REID, the chief medical officer, places at 600 feet above the level of the sea.

“ In his report on the fever, he mentions a curious fact about the spread of the fever into a section of Black River and Savanne, always known as the healthiest part of Mauritius. Between these districts and the infected ones lies a barrier of forests and woody elevations. He writes, ‘ During the first week of January, 1868, occurred a hurricane, the

main force of which was from the south-east and east. in that extremity of the island sufficiently strong to spoil the forests of their leaves, and make gaps in this barrier of wooded highlands, and thus carried in the fever germs from the part of Black River, where fever was rife, to the hitherto healthy inhabitants.'

"I could add greatly to these details; but those I have mentioned are sufficient to show that, with all these existing powerful agents to malaria lying dormant, and so many spore-beds waiting for peculiar atmospheric influences to set them free, the heavy rains, and then excessive drought followed by hurricanes, would act on them with fatal certainty, and thus strike the whole island with this terrible plague, converting, for the time being, the once 'Gem of the Ocean' into a very pest-house.

"Dr. REID also mentions in the same report a circumstance which would seem to corroborate the fact alluded to on p. 98, as to the effects of the cinchona, as stated by DECANDOLLE.

"He says, 'The waters of the few remaining woodland marshes of Mauritius, the Mare aux Vacoas, aux Jones, and Bassin Blanc, are deeply tinged and impregnated with tannin and resinous matters, and the inhabitants around and near these marshes entirely escaped the fever.'

"He suggests, and very properly, 'May not this exemption be due to the tannin, and other products of the débris of the surrounding forest, being present in these localities, and preventing the fever germs from flourishing therein? May not the removal from the humus and marshes of the lowlands of similar substances, which they received when the island was well wooded, have been one of the changes which prepared them for the reception and development of amalarious germs?'

"I do not doubt it; and it is most likely the withering effects of the different barks in solution, that prevented the germination of the fever-spores in those marshes, and caused the consequent immunity of the neighbouring inhabitants from the disease."

I do not think it is a waste of the Society's valuable time to see how men groped in darkness and how they tried to explain phenomena which nowadays we fully understand. In respect of certain diseases we stand where they stood as regards malaria, and a consideration of their errors and of their strivings towards the light may aid us to avoid pitfalls and guide us to a correct explanation of the problems with which we are faced.

Some of these exist to-day in Mauritius, which we shall now study from various aspects of hygiene by means of lantern slides prepared from photographs I took during six months' inspection and advisory work in this famous and unique little colony, which the 1921 census has shown to possess a population of 376,108, of whom the great majority are Indians.

Over 120 lantern slides were exhibited illustrative of the following subjects :—

1. Geography of Mauritius.
2. Scenery of the island.
3. Malaria and antimalarial work.
4. Mosquitoes other than anophelines and antimosquito work.
5. Water supplies.
6. Washing arrangements.
7. Waste-water disposal.
8. Food.
9. Conservancy.
10. Refuse and refuse disposal.
11. Plague.
12. Ankylostomiasis.
13. Buildings of various kinds and sanitary and insanitary premises.

A selection of the above is here reproduced to illustrate the more important points considered :—

Geography.—A map of Mauritius was exhibited and the chief physiological features of the island explained. Special attention was directed to the intensely malarious Black River district, an area of comparatively level land lying between high hill ranges and the sea.

Scenery.—Various views were shown, especially of the waterfalls, for which Mauritius is famous. Pictures of certain of the hill ranges and the larger rivers were also exhibited, together with illustrations of the beautiful coast scenery. Slides of Port Louis and its harbour formed a feature of this section, and an old plan of the capital showed the general layout of the town and its immediate surroundings. Stress was laid on the Port's similarity in many respects to Port of Spain, Trinidad, and, from the point of view of plague, attention was directed to the fact that large ocean-going ships lie out in the harbour and do not tie up to wharves or quays.

1.—The island is well supplied with both roads and railways.

2.—The Moka Hill Range from Pamplemousses, showing the lofty summits of Pieter Both on the left and the Pouce in the centre.

3.—Dia Mamour Falls, Grand River, S.E.

4.—View of Port Louis Harbour and Town from the sea, showing the Moka Range in the background with the Pouce Mountain in the centre.

5. —Old map of Port Louis, showing the relations of the town to the surrounding hill ranges. The town is now not so extensive as here indicated, a considerable portion of it having been destroyed by the great hurricane of 1892, and never having been rebuilt.

6. —View across Baie du Cap. The mass of Morne Brabant in the background.

7—View of Grand River, S E

8.—Monument in the Bois Marchand Cemetery to a large number of the men of the Mauritian Police Force who died of malaria during the great epidemic.

9.—A leaking "Regard" in one of the Port Louis streets—
breeding-place for *Anopheles costalis*.

10.—An overgrown and neglected watercourse on a sugar
estate, Pamplémousses.

11.—Uncanalised River Française near Poste de Flacq.

12.—A typical marine swamp in the north of the island.

13.—An inland swamp at La Lucie, Fracq.

14.—La Ferme Reservoir. The water is at a comparatively low level and convenient breeding-places for *A. costalis* are provided.

15.—Portion of Black River at the time of Ross' and Fowler's visit, 1908.

16.—Same portion of Black River at the present time.

17.—La Paix stream at the time of Ross' and Fowler's visit, 1908.

18.—La Paix Stream. Very nearly the same spot during the dry season at the present date.

19.—Mosquito trap-pool protected by rabbit wire netting from the assaults of pigs and other animals.

20.—Canalised stream shaded by Jamrosa trees (*Eugenia jamrosa*) and free from the larvæ of *A. costalis*.

21.—Canalisation of a water-course traversing Port Louis.
Note the excellent old Pavé, the side drains and the
hill range in the background.

22.—The canalised Rivière Sèche, District of Flacq.

23.—A "mosquito tower" in Pamplemoisses district.

24.—Bamboos broken by hurricane and forming nurseries for the larvæ of *Stegomyia scutellaris*.

25.—One of the ever-running taps leading not only to a great waste of water, but to the formation of mosquito breeding-places—outskirts of Port Louis.

26.—A well-cover made from the end of a sugar-factory boiler. Ample opportunities for pollution during the drawing of water.

27.—Underground rainwater-tank, Quarantine Station, Canonnier's Point. The water is derived from roof-washings, and as the first washings are not rejected, is somewhat impure. Moreover, the pump had broken down, and consequently resort has been had to dipping, which tended towards pollution of the supply.

28.—Latanier stream near Port Louis, showing native washerwomen at work. This photograph also shows how the stream has been canalised in solid rock.

29.—Disposal of waste water. Arrangements at British Barracks at Vacaos. Large covered soak-pit in foreground. The soil here is very porous.

30.—Group of milk-vendors. Tins are of a fairly good type, but their contents only faintly resemble milk, as the product from the cow has had the fat removed, has been boiled, and had water added to it. Nearly the whole milk supply of the island is in a very unsatisfactory condition.

31.—A strange and antiquated vehicle employed for conveying meat from the slaughter-house to the market, Port Louis. It is lined with zinc, but, as will be seen, the fly-proofing is distinctly defective. As a matter of fact the gratings are more for ventilation than for the exclusion of flies.

32.—A corner of the central meat market, Port Louis. A story not needing words

33.—Large covered market in Curepipe. This is the only really good market in Mauritius.

34.—Fish form a staple article of diet in Mauritius, and the photograph shows a basket of fine white mullet.

35.—A typical night-soil cart, Port Louis. It is furnished with sliding-doors, which render the interior dark. The tubs are of wood, and become very foul.

36.—An open type of engrais or manure pit. The sweeper is shown emptying the contents of a latrine bucket into the cement concrete tank. The human excrement is mixed with cane trash and rubbish of various kinds, and the mass is eventually used for manuring the cane-fields.

37. — Boat employed for removing a portion of the contents of the sewers, which, owing to partial failure of the pumps and the small size of the outfall are insufficient to deal with the total daily flow. The boat discharges its contents in or outside the harbour and is a happy hunting ground for flies.

38. — Interior of one of the pits at the Roche Bois Manure Factory, Port Louis. The containing wall is broken and pigs have access to the human excrement.

39.—Plan of fumigating-pit as now employed in parts of the Belgian Congo. These pits are being introduced into the sugar estates in Mauritius.

40.—A refuse heap and rat playground on the harbour front, Port Louis.

41.—Coasting vessels at Souillac, showing lack of precautions as regards the ingress and egress of rats.

42.—A Clayton apparatus at work during the plague epidemic in Port Louis.

43.—This illustrates the stunting effect of ankylostomiasis on growth. The boy in white is a victim of hookworm disease and is sixteen years of age. The other boy is twelve and was found uninfected.

44.—One of the male wards of the Leper Asylum, at St. Lazare, Port Louis. Note the grass brooms which are manufactured by the lepers, and sold by them to the general public.

45.—Type of insanitary yard, Port Louis.

46.—Type of better-class Indian's house.

47.—A Sugar Estate Crèche, where the children are looked after while their mothers are at work.

48.—Portion of the model village being erected by Sir Hesketh Bell at Cassis, on the outskirts of Port Louis.

49.—The Bacteriological Laboratory, Réduit.

50.—Date-palm, showing the nests of weaver birds placed at the ends of the leaf fronds as a protection against monkeys, and exemplifying the truth of the proverb, "Prevention is better than cure."

Malaria.—In the first place, a picture was exhibited of a tombstone in the Bois Marchand cemetery, erected to a large number of the members of the police force who died during the terrible malaria epidemic of 1866 to 1868.

Following this, a series of views was displayed, showing the various breeding-places of *Anopheles costalis*, both in urban and rural districts. So far as the former is concerned, the liability of the so-called "Regards," which are prevalent in Port Louis, to form mosquito nurseries was made the subject of comment. It was explained that a "Regard" was a pit in the street, containing the junction of the pipe from the water-main and the supply-pipes to the house. Owing to the fact that the water of Port Louis, being unfiltered, contains much silt, a blockage is apt to take place at the point of junction. The householder endeavours to remedy this by tampering with the screw-down taps, and, as a result, leakage frequently occurs, and mosquitoes gain access to the water in the pit. Mention was made of a device designed to take the place of the "Regards" and render them unnecessary.

The rural breeding-places comprised swamps (both marine and inland), rivers, streams, ponds, irrigation pits and canals, and special attention was directed to the fact that *Anopheles costalis* does not breed in streams shaded by trees, because the green alga on which its larvæ feed is not found in such situations. Mention was made of Dr. CASTEL's observations in this connection.

A map was then exhibited which showed the very extensive major antimalarial works which had been carried out in the island since Major Ross's visit, and a further idea of what had been done was given by a number of slides showing various kinds of antimalarial operations, more especially those connected with the training and canalisation of rivers and streams. In two instances it was possible to compare pictorially the conditions at the time of Ross's visit and those which now obtain, and a very marked change was visible in the case of a stream in the neighbourhood of Port Louis and a river in the Black River district. The question of *Lemna minor* as a mosquito deterrent was discussed, and the statement made that the work of the SERGENTS in Algiers had apparently shown that this water-weed has not the beneficial effect of *Azolla filiculoides* in preventing ovipositing in sluggish streams and ponds.

A picture of a trap-pool was shown, and the use and value of these

contrivances explained ; while a mosquito-tower was displayed somewhat similar to those used for preventive purposes at certain railway stations in the Caucasus. Other antimalarial measures were discussed, and attention was then directed to—

Non-malaria-carrying mosquitoes and the measures taken to deal with them.—The rôle of *Culex fatigans* as a carrier of filariasis was mentioned, and the statement made that in all probability *Stegomyia albopicta* (*scutellaris*), which is so common in the island, was also a vector, as was known to be the case in Malaya. One of its favourite breeding-places, namely, flower-vases in cemeteries, was shown, in addition to such nurseries as snail-shells, barrels, and broken bamboo stems.

Water Supplies.—Pictures showing the aerating and oxidation plants at the La Marie Filter Works paved the way for the consideration of many matters connected with water supply in Mauritius. The source, storage, and distribution of water were all passed in review, and pictures illustrating fouling of well-waters formed a feature of this section. Comment was made on the waste of drinking-water and its attendant evils, and the measures taken to remedy these evils were explained and illustrated.

Washing.—The manner in which streams and rivers are fouled by the custom of washing clothes in them was next shown on the screen, together with a picture of an open-air laundry.

Waste-water Disposal.—Under “Waste-water Disposal” a single slide was exhibited, which showed the excellent arrangements in connection with the British barracks at Vacoas, where the great porosity of the soil enables well-constructed absorption pits to function admirably.

Food.—Examples of different kinds of food-stuff were shown on the screen, both the necessities and luxuries being represented. Special attention was directed to the question of milk supply, and pictures of cowsheds and milk sellers helped in the elucidation of the subject. The lecturer ranged from slaughter-houses to markets, and the insanitary condition of the central market in Port Louis, and the means taken to remedy it, figured prominently. The excellent, large, covered market at Curepipe received a meed of praise, and then attention was directed to various—

Conservancy Problems, and pictures were shown illustrating the comparative failure of the sewerage scheme in Port Louis, its success in connec-

tion with the British barracks at Vacaos, and the deplorable conditions existing in connection with the pail system of removal, so general in the island, and more especially the disgraceful state of matters at the Roche Bois Manure Factory near Port Louis, and the somewhat similar establishment which serves Curepipe. The so-called Engrais system was explained and condemned, and some of the remedial measures proposed were illustrated by appropriate slides, notably, the introduction of the "fuming pit" or smoke latrine system, as now practised on a large scale in the Belgian Congo.

Refuse and Refuse Disposal.—These received attention, and the danger of faulty scavenging in connection with the spread of plague by rats was indicated by several illustrations. This led to the exhibition of a series of slides connected with—

Plague and the Anti-Rat Campaign in Port Louis. Amongst others, the Clayton apparatus was shown at work, and the possibility of danger from island schooners tying up to wharves explained.

Then followed No. 12, a picture showing the stunting effect on growth by—

Ankylostomiasis, which is so prevalent in Mauritius, and mention was made of the aid which is to be rendered by the Rockefeller Foundation. The question of—

Housing was thereafter taken up, and a number of photographs passed in review, illustrating not only various dwellings but showing special institutions, as, for example, a crèche on a sugar estate, different kinds of hospital wards, and the model village recently erected by the Governor, Sir HESKETH BELL, at Cassis, near Port Louis.

Pictures of dipping tanks for cattle were also exhibited, and special attention was drawn to a photograph of the useful Bacteriological Laboratory at Réduit, of which Dr. BARBEAU is in charge. Its value from the point of view of preventive work was emphasised, and, finally, the lesson that prevention is better than cure was inculcated by a picture of a date-palm, which showed at the very extremity of its fronds the nests of weaver birds placed there as a protection against the attacks of monkeys.

In the course of the demonstration tributes were paid to the work of several Mauritian doctors and entomologists. The lecturer acknowledged the assistance rendered him by many officials, notably his Excellency the Governor and Mr. E. B. DENHAM, C.M.G., the able and energetic Colonial

Secretary. Mention was also made of the good work which was being accomplished in Port Louis by the recently appointed Medical Officer of Health, Dr. T. B. GILCHRIST, who would soon be a Fellow of the Society, and of the advantages likely to accrue from the recent visit of a Consulting Sanitary Engineer in the person of Mr. E. L. MANSERGH.

If only Mauritius were freed from those plagues we have considered, and others which render it notoriously unhealthy, its future might, I believe, be assured. There could be no more delightful holiday resort, and no great distance away lies the Union of South Africa, a large and wealthy country developing by leaps and bounds. It has a population, especially in Johannesburg, which looks for rest and change, and nowhere could these be better enjoyed than in the old home of the dodo. At present people are deterred from going there owing to its unenviable reputation for unhealthiness, but if this were abolished there is no reason why hotels should not be built, large golf links laid out and various developments undertaken.

It is possible that thereby the island might lose some of its charm, but it would benefit financially, and it might be expected that its hygienic condition would materially improve, if only because further funds would be available for the upkeep of sanitary works.

All this is no vain dream. We know what has been done elsewhere, wherever modern knowledge has been applied vigorously and along sound lines.

It is only by hard and incessant work that Mauritius can be rendered healthy, but its transformation from a disease-stricken colony to one noted for salubrity is undoubtedly a feasible proposition. It is a question of money, energy, co-operation, education, application of scientific principles, and persistence. The thing can be done, and it is certainly worth doing.

Hence let us hope that now a start has been made under more favourable auspices than in the past there will be no back-sliding, but a steady progress towards the twin goals of health and efficiency.

In the olden days Mauritius, the ancient Isle de France, gained for itself the proud title of the Star and Key of the Indian Ocean. I hope yet to see it become, as apparently it was many years ago, a veritable Sanatorium, a Star of Hope to the sufferer, a Key to the Door of Health.

DISCUSSION.

The CHAIRMAN : I think we must congratulate Dr. BALFOUR on that very fine lecture which he has just given us, and the beautiful photographs. You will excuse me for saying that it has delighted me beyond measure to hear all these things, and to see in these pictures parts of Mauritius which I had never seen before when I spent nearly fourteen months there with Major FOWLER. At that time we had only to deal with malaria. I have not heard much of what happened in the island since then. Mr. DE CHARMOY was there at that time, and I believe he is still there, though not at the same work. They have not carried out all the recommendations in my report. Dr. CASTEL, the head of the malaria part of the work, ought to have had his attention confined to malaria. They take one's advice in part, but not fully.

I am glad to hear the island has progressed, and that there has been some improvement, though, apparently, not such great improvement as has occurred in Cyprus. I went to Cyprus in 1913. and there the reduction of disease had been very marked.

I am delighted to hear Dr. BALFOUR mention my proposal that we should introduce *Anopheles rossi* into the island; but they would not allow it. I do not know why. I only thought of it just before leaving; I had not time to press it. But I think it might eat out the *costalis*. As to the Mauritanus, I do not think that carries; we could not get a single malaria parasite to develop in that, but the first *costalis* we caught was infected.

All the other sanitary details which Dr. BALFOUR has given us are exceedingly interesting, and he has shown his usual wit and dash in his lecture, and, as I have said, we must congratulate him on it.

I shall not say any more, but I will call upon Dr. LAURENT, who was formerly mayor of Port Louis; he was mayor of that town when we were there, and he helped us very largely. I have a great opinion of the municipality of Port Louis. They have an Opera there, which shows that they look after their sanitation, and Dr. LAURENT was looking after the sanitation very considerably when I was in the island.

Dr. EUGÈNE LAURENT : I am pleased to meet here an old friend, Sir RONALD ROSS, and to make a new acquaintance, Dr. ANDREW BALFOUR; because during my stay in Mauritius Dr. ROSS was sent as an

expert, and he did very good work there indeed. He is right when he says the Government never helped him a bit, and he knows that practically all the work which has been done has been done by the municipality. In the drainage, for instance, we had a splendid expert, Sir OSBORN CHADWICK, who certainly gave the necessary directions, and even left Mr. BRINE to carry out his directions, yet the whole thing was messed considerably by the Government, who tried all the time for economy, and especially delays. The Government has been at the drainage of the island for thirty-one years, and Dr. BALFOUR has given you instances of what the Government did in Mauritius for sanitation. Beyond this, you know that in the suburbs of Port Louis, which might well be called the ante-room of death, the Government has full sway. You will remember, Sir, that I took you round the streams of Rushbury, Maure Rouge, Valley Piteau, and so on, and you saw that all those places had been sadly neglected; so much so that the municipal zone was overcrowded by people who had migrated from the Government zone. I think that is a crucial test. If people migrate to the maligned municipal zone to escape malaria, that is the answer to those who criticise the municipality. Had there been sufficient money available, I think the excellent directions given by Sir RONALD ROSS would have been more successfully and thoroughly carried out by the municipality. I wanted, in 1917, before I left the island, to have a clear indication of the work done by the Government and by the municipality; so I got our sanitary wardens to take the spleen rates in the different schools in the municipal zone and in the zone directly under the control of the Government. The schools under our control gave a 10 per cent. spleen index, whereas on the Government side it ran up to 74 per cent. So that evidently the work done since 1908, the date of the visit of Sir RONALD ROSS, was much more efficient when done by the municipality than was done by the Government. Dr. BALFOUR has forgotten to tell you that before 1867 the island was certainly a sanatorium. But we have now had introduced there so many Indians, for working on our sugar plantations, that apparently all the diseases upon earth were introduced at the same time to our native coolies. And, somehow, the Medical and Health Department, under the control of the Government, did nothing to prevent the introduction of disease, and when disease was introduced there was the greatest difficulty in eradicating it. I think that with the new

instructions given by Dr. BALFOUR, and with the co-operation of the public, something useful will be done. In fact the municipality, now having more money, will be able to do much of what was left undone owing to lack of sufficient means. You know that in 1908 we had to get Commissioners in Mauritius to look into our finance; the Government had been so improvident that we were on the verge of bankruptcy. But, even at that time, the municipality had no deficit, whereas the Government had more than a million pounds deficit yearly. So, altogether, you see the management was not so unwise on the part of the free institution.

I am sure you will join me in congratulating Dr. BALFOUR on a most useful report, which he has presented this evening, on Mauritius. Everything was very interesting indeed, and, for my part, I enjoyed it thoroughly. I beg to propose a vote of thanks to Dr. BALFOUR, who was your worthy successor.

This was carried, and Dr. BALFOUR very briefly acknowledged it.