THE PREVENTION OF MALARIA IN BRITISH POSSESSIONS, EGYPT, AND PARTS OF AMERICA.¹

(Report to Section VII. of the Fourteenth International Congress of Hygiene and Demography held in Berlin, September, 1907.)

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(Continued from p. 170.)

V.—Campaign at Hong Kong.

One of the earliest and best of the campaigns in British territory. The city of Victoria, usually called Hong Kong, runs for nearly 5 miles along the north of the island of that name at the mouth of the Canton river in South-east China. The island, 11 miles long, and from 2 to 5 miles broad, consists of a broken ridge of hills, rising to nearly 2,000 feet, and the city is built on a hill sloping down to the water, some of the terraces and houses being 500 feet above sea level. There is also a large residential district on the mountains reached by a cable tramway. The soil is granitic. All along the face of the hill on which Victoria is built there are beds of streams, known as “nullahs,” which used to swarm with anopheline larvae. The population of the colony was 377,850 in 1905, of which 10,835 were whites (nearly half belonging to the British Army and Navy). The rainfall is from 70 to 80 inches a year. Malaria has always been very prevalent here, and I remember that in 1881 the colony was cited as an example of the telluric miasma due to decaying granite. The first researches on the new lines were commenced as early as May, 1901, by Dr. J. C. Thomson,² who undertook an exhaustive study of the mosquitoes and their breeding-places. He examined over 32,000 specimens, of which he found about 4 per cent. to be anophelines, and in November advised an active anti-malaria campaign by drainage, clearing of jungle, “training” of the nullahs, the use of wire gauze, oiling pools, and quinine prophylaxis. As seen by his excellent papers,³ his recommendations were not of a general nature, but

¹ Also printed in the Lancet, September 28th, 1907.
³ Ibid., “Malaria Prevention in Hong-Kong.” Official report, containing many letters, 1900-1903.
were particular, practical, and exact. These recommendations were rapidly acted upon by the Government. Since 1901 all the nullahs or water-courses within and near the city were "trained"—that is, rendered so smooth and even that the anophelines could no longer breed in them; and much similar work was done wherever most needed elsewhere by "training" water-courses, buying up rice fields, and so on. The details of the campaign are so numerous that it is impossible to give them here. They will be found in the publications given in the bibliography, and in a good paper by Mr. J. M. Young, who took part in the early stages of the work. The results are given in the annual sanitary reports of the colony and in a recent address by the medical officer of health, Dr. W. Francis Clark. Dr. Thomson informs me that before estimating them, it is necessary to remember that malaria can never become extinct in Hong Kong, owing to the fact that some 3,000 to 4,000 natives come and go from and to the country districts every day, and that a number of these will remain infected in spite of all local measures. Nevertheless the figures show a rapid diminution both in the admission- and in the death-rates.

<table>
<thead>
<tr>
<th>Malarial Districts of Two Large Hospitals.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td>1897</td>
</tr>
<tr>
<td>Admissions</td>
<td>1,021</td>
</tr>
<tr>
<td>Deaths</td>
<td>197</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admission-Rate of Police for Malaria.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td>1896</td>
</tr>
<tr>
<td>Admission per cent.</td>
<td>32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deaths from Malaria.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td>1896</td>
</tr>
<tr>
<td>Population</td>
<td>239,419</td>
</tr>
<tr>
<td>Total deaths</td>
<td>583</td>
</tr>
<tr>
<td>Deaths in city (Chinese only)</td>
<td>290</td>
</tr>
</tbody>
</table>

The official sanitary reports give similar figures. The improvements have, of course, varied much in different localities. Thus in 1900 the western end of Bonham Road used to be one of the worst

2 Clark, "An Address on the Prevention of Malaria in Hong Kong." Noronha and Co., Hong Kong, 1906.
Ronald Ross

districts. Now in 1905 it is reported not to have sent a single case to the Government Civil Hospital.\(^1\)

With regard to cost, Dr. Clark reports that up to the end of 1905 the Government had expended about £5,000 on anti-malaria measures, and estimates that £6,500 would be spent by the end of 1906—a small amount to pay for the good that has been done. The campaign in such a thickly populated district must be difficult. A larger expenditure would probably have produced still more marked results, and it would have been useful to estimate the endemic index in various parts of the area. I am much indebted to Dr. Thomson and also to Mr. J. Bell for the detailed information which they have been so kind as to send me, but which I have no space to give more fully.

VI.—CAMPAIGNS IN INDIA.

In 1898 I had hoped that India would have led the way in the matter of malaria prevention. Long previously the Government had done very well by issuing cheap quinine in malarious localities, and by making several local enquiries. The disease existed more or less throughout the country, and in some military stations caused an admission-rate of several thousands per mille, while in other places it was an extremely serious detriment to development. There were numbers of places as dry and easy to deal with as Ismailia; while few presented worse difficulties than the towns in the Malay States. The military stations were under the complete control of the authorities, and experienced administrators, sanitary officers, and engineers abounded everywhere. So far as I can ascertain, however, little or nothing was done for several years. The first active campaign seems to have been inaugurated in 1902, as an experiment, at Mian Mir in the Punjab, but was most unfortunately a failure, at least at first.

Mian Mir.—This is a large cantonment or garrison town situated on the flat and hot plains near Lahore. Constructed in 1851-52 in the midst of what was then an arid and treeless desert, it was later well watered by irrigation canals. The result was that malaria began to prevail to such an extent that in 1879 the annual admission-rate for fevers rose to 3,427 per 1,000 of the troops, and the place was called “the white man’s grave.” In 1901, however, Dr. Stephens and Captain Christophers, of the Malaria Commission

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\(^1\) Reports on the Health and Sanitary Condition of the Colony of Hong Kong, 1900-1905, p. 54.
of the Royal Society, were sent on my suggestion to India, and investigated the mosquitoes of Mian Mir, amongst other places. In April, 1902, practical operations were commenced, evidently on the Sierra Leone model, by Captain S. P. James, I.M.S., and afterwards by Captain S. R. Christophers, I.M.S. The results, however, were not only negative, but were stated in such a way by these observers as to suggest that mosquito reduction was generally a difficult if not impossible task. The writers had evidently failed to grasp the subject, for they attempted an important work without adequate expenditure, and made other mistakes. Their reports were exhaustively criticised by Giles, Sewell, and myself, but they nevertheless retarded Indian anti-malarial efforts for some time.

Since then, to judge from accounts in the Indian sanitary reports, and from details very kindly furnished to me by Surgeon-General A. Scott Reid, I.M.S., and Lieutenant-Colonel H. D. Rowan, R.A.M.C., wider measures have been attended with better results. Since 1905 the following measures have been adopted. The principal irrigation canal and its branches were closed within a radius of about 800 yards of the barracks and officers' quarters. The surface of the ground was everywhere levelled and the drainage improved, so that even after a heavy fall of rain, not a single collection of water will be found after seventy-two hours (except a large pit which is in course of being filled in). The whole cantonment was divided into six areas, each under a medical officer, and each area is visited once a week by a strong "mosquito brigade." All wells are protected, and those used for irrigation purposes are oiled once a week. Quinine is administered twice a week, on consecutive days, from June to November, under medical supervision. Residents are held strictly responsible for the condition of their compounds (gardens). No undergrowth or rubbish is allowed, nor pits for the reception of sullage water; and other general sanitary improvements have been made.

1 Stephens and Christophers and James, "Reports to the Malarial Committee," Royal Society, 7th and 8th Series, 1902, 1903. Harrison and Sons, London.
2 James and Christophers, "Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India," First and Second Reports of the Anti-Malarial Operations at Mian Mir, No. 6, 1903, and No. 9, 1904.
3 Giles, "Cold Weather Mosquito Notes from India," Journal of Tropical Medicine, April 1st, 1904.
4 Ross and Sewell, British Medical Journal, September 17th, 1904.
In estimating the results Colonel Rowan remarks that the statistics of mortality in the civil population cannot be relied upon, and that there are difficulties in connection even with those of the troops. Since 1905 cases have been returned as malaria only when a microscopic diagnosis has been made, and are otherwise given under the heading of "simple continued fever" (exclusive, of course, of typhoid or undulant fever); but he remarks that this is not quite fair amongst men who are getting quinine with such regularity. He thinks it best to take the admission-rates for malaria and simple continued fever together, and these show a considerable decline.

For the five years 1898-1902, the average annual admission-rate per 1,000 of the British (white) troops was about 900. In 1903 it was nearly 1,100; but in 1904, 1905, and 1906 it fell to about 600, 400, and 460 respectively. The general admission-rates for all disease among these troops were 1,950 in 1898-1902, 1,800 in 1903, 1,350 in 1904, 1,350 in 1905, 1,240 in 1906. In a native cavalry regiment which has remained in Mian Mir for the whole of 1904, 1905, and 1906, the admission-rates for malaria per 1,000 have been 242, 108, and 43 respectively. On the whole, he is satisfied with the success of the campaign, but thinks it too early to form an estimate of the full extent of the gains. I am told also that the fact that the troops have to serve frequently at Fort Lahore, a very unhealthy place, does much to distort the figures. But the measures are reported (1, p. 231) to "have undoubtedly contributed to the decreased prevalence of anopheline mosquitoes and their larvae during the year." Colonel Rowan tells me that culex are much less common and that anophelines "have become positively rare," although a native is specially employed to find them if possible.

Progress of Events.—In January, 1902, a conference of medical men on the subject of malaria was held at Nagpur. It drew up an excellent set of rules for anti-malarial sanitation, but so far as I can gather, no general orders were issued to make the rules compulsory. Gradually, however, several stations began to adopt measures on a small scale, chiefly, I think, owing to the initiative of individual medical officers, though the results at Mian Mir were frequently used to discourage them. Apart from practical work numerous good articles on mosquitoes and their habits appeared.2

1 Colonial Reports, Annual. Wyman and Sons, London.
of the campaigns because the full facts are not obtainable, but
I will refer briefly to the following.

Major W. J. Buchanan, I.M.S., Inspector-General of Prisons
in Bengal, has been good enough to give me some details of his
campaign at Buxor Central Gaol. Buxor, in Bengal, is full of
malaria, attributed to the large number of small irrigation canals.
The gaol is a good one, well situated and drained, but it has one
irrigation canal entering it in order to supply water. In June,
1904, Major Buchanan had the canal banks close cut, cleared
and tarred, and gave similar treatment to certain tanks. All
pools, puddles, and hollows were filled up, and land in a neigh­
bouiring village was acquired for the purpose, while quinine was
given every Saturday and Sunday during the malaria season.
The results among the prisoners (averaging about 1,400) were:

<table>
<thead>
<tr>
<th>Years</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
<th>1905</th>
<th>1906</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissions for malaria</td>
<td>2,091</td>
<td>2,455</td>
<td>1,267</td>
<td>1,207</td>
<td>1,191</td>
</tr>
</tbody>
</table>

It should be remembered that prisoners are constantly being
changed, new and infected criminals being frequently introduced
from outside. Major Buchanan adds that he is adopting similar
measures in all gaols. He approves of quinine prophylaxis
in addition.

In the Madras Presidency, Colonel W. G. King, I.M.S., the
Sanitary Commissioner, took early interest in anti-malaria work
and commenced to organise mosquito brigades; and in 1904 the
Government was reported to have taken active steps in this
direction. It accepted Colonel King's scheme, suggested a suitable
organisation, and advised municipal councils to meet the expendi­
ture required.1 I have not yet seen any description of the results.

Captain C. A. Sprawson, I.M.S., has been kind enough to give
me many details of the work at Jhansi, a town of 12,457 inhabi­tants in Bundelkand. Operations appear to have been started at
the beginning of the rains in 1906. The cantonment was divided
into two areas, one for the white troops and one for the native
troops, each division being placed under the appropriate medical
officers under whom mosquito brigades were appointed. The
native quarter was also looked after. Instruction regarding
malaria was made public. The money allotted for the actual
work, however, appears to have been rather small, as it was not

1 Indian Medical Gazette, January, 1905, p. 30.
allowed to exceed about £23 a year—less than \( \frac{1}{3} \)d. per head of population and 2d. per acre of land. As a matter of fact, the admission-rate for malaria seems to have increased rather than diminished, for it was 246.5 per cent. in 1906 against only 71.8 per cent. in 1905. The surrounding villages appear to have been left untreated, and the cantonment itself is full of borrow-pits.

Although campaigns seem to have been at least commenced in many stations in India, I can gather only meagre and insufficient information about them in the official reports. At Jubbulpore and Dinapore considerable drainage and anti-mosquito works, combined with quinine prophylaxis, appear to have produced marked effects (1, p. 16). Active, and so far as I can ascertain (2, p. 230) enthusiastic, measures have been adopted at Peshawar, Rawal Pindi, Sialkot, Ferozapore, Karachi, Mhow, Kamptee, Deesa, and Saugor; and in Burma (3, p. 6), at Akyab, Myitkyina, Monywa, Paletwa, Mogok, Kyaukpyu, and Maymyo. At Mogok Captain J. Good, I.M.S., reports a diminution of malarial fevers (diagnosed by the microscope) from 25.4 per cent. of admissions in 1905 to 16.4 in 1906. As a rule, however, neither results nor expenses are given in the official reports.

The total amount of malarial fever in India, with its population of about 300,000,000, is immense. There must be several millions of deaths directly or indirectly due to it every year. Among the troops and prisoners in gaols the annual number of admissions into hospital for malaria equal between a quarter and a half of the total strength. It is therefore very necessary that all the anti-malarial work throughout the country should be dealt with in a business-like manner, and that the results obtained should be collected and published for guidance and study.

VII.—Other Campaigns.

Khartoum.—This very interesting work was commenced in 1903 by Dr. Andrew Balfour, Director of the Wellcome Research Laboratories of the Gordon Memorial College, and will be found accurately described in the two fine reports of the laboratories, to which I must refer for details. After a preliminary survey of

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the local mosquitoes, a small brigade was started on the lines laid down by me, and quickly attacked the breeding places. These in Khartoum were wells, pits, garden tanks and pools, sullage pits, river pools, and collections of water in steamers and barges. After heavy rain large pools which may last for some time form on the flat ground and used to breed many mosquitoes. All these waters were attacked by various methods, with the result that the larvæ were found in quickly decreasing numbers. Now, in his second report, Dr. Balfour remarks that, although mosquitoes have not been completely banished, yet "we are rid, and well rid, of the annoying stegomyia, the dangerous pyretophorus is kept in abeyance, and culex, the ubiquitous, has ceased to be a nuisance." He adds: "I have not seen a living, wild, adult anopheline in Khartoum for more than a year and a half, and I am always on the lookout for these insects." The effect on the amount of malaria could not be estimated owing to the absence of statistics and to the fact that malaria was never very prevalent there. If by accident the insects are allowed to recur, malaria reappears; and he tells me that since the date of his second report, six primary cases have been caused in this way, though the outbreak was promptly suppressed. Owing to the assistance of Lieutenant-Colonel R. H. Penton, D.S.O., R.A.M.C., Principal Medical Officer of the Sudan, the work was extended. Surrounding villages are heavily infected, but excellent rules regarding irrigation are being introduced. Dr. Balfour and his colleagues are to be warmly congratulated on their work.

Some years ago Colonel Penton asked me to go to the Sudan to advise regarding the prevention of malaria there. I was unfortunately unable to accept the invitation, but he himself has carried out excellent work with considerable success at Kassala and El Obeid, besides Khartoum. In Port Said (56,000 inhabitants) an active campaign has been conducted by my brother, Mr. E. H. Ross, against the mosquitoes there. The result is, he says in a letter dated last March, that there "was been almost complete absence of the pest in a year's work. No case of acute malaria has been admitted to hospital since August last. There has been a reduction in the death-rate. . . . At Ismailia the


results are well known. There is now a complete absence of mosquitoes and of malaria. But in some of the villages round there is much malaria and many anopheles, owing to the irrigation.” In Cairo, in the district of Kasr-el-du-Barra, and Helowan, campaigns have been organised with success by my brother, Mr. H. C. Ross. This Egyptian work has been carried out with the sanction and approval of Sir Horace H. Pinching, the distinguished head of the Sanitary Department of Egypt.

Candia, Crete.—The accounts of this excellent campaign, conducted in connection with the British troops in Crete, will be found in successive numbers of the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS. The town of Candia, containing 21,000 inhabitants, is situated on the seashore of a semicircular plain bounded by hills. The rainfall is heavy and the ground is traversed by many streams which become torrents in winter and nearly dry in summer. Two of them have marshy margins near the sea. The houses of the town are of the Oriental type and contain many wells. The troops are accommodated in quarters to the west of the town and close to it, and suffer considerably from malaria. Apparently as early as 1902, Lieutenant-Colonel J. V. Salvage, R.A.M.C., commenced to examine into the distribution of anopheles and to destroy the larvae by drainage, or by closing or oiling the wells, or putting fish into them, and expressed himself hopefully regarding the result. In March, 1903, Major (now Lieutenant-Colonel) C. J. Macdonald arrived in Crete and continued the work. He gives many very interesting details. Works of a permanent nature were attempted and quinine prophylaxis and mosquito nets insisted upon. The first results were as below:

<table>
<thead>
<tr>
<th>Years</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength</td>
<td>564</td>
<td>460</td>
<td>410</td>
</tr>
<tr>
<td>Admissions</td>
<td>1,540</td>
<td>1,084</td>
<td>227</td>
</tr>
<tr>
<td>Rate per cent</td>
<td>273</td>
<td>296</td>
<td>55</td>
</tr>
</tbody>
</table>

The admissions include simple continued fever, together with malaria, in order to avoid error due to diagnosis. Colonel Macdonald attributes the fall to the measures taken. In 1905 Captain R. A. Cunningham, R.A.M.C., adds a third article, in which he states

that the fall in the malaria-rate had continued, and was only 30 per cent. in 1904 compared with the 55 per cent. in 1903. The mosquitoes were so few that it was almost unnecessary to use a net at night. In 1905 (1, p. 103) there were 246 admissions, or a rate of 38.7 per cent. Many men became infected on guard and outposts.

St. Lucia.—A good account of this work has been given by Lieutenant-Colonel F. P. Nichols, R.A.M.C.2 British troops have long been stationed at Castries, St. Lucia. During 1902 and 1903 drainage works were carried out by Colonel Hodder, of the Royal Engineers, but shortly afterwards the garrison was removed. Colonel Nichols has attempted to ascertain the effect of the operations on the health of the troops before they departed. He gives many interesting cases, and remarks: "The apparent effects were very marked, as noted by both officers and men, by Major Bent, R.A.M.C. (to whom I am indebted for many notes on the point), and by the other Royal Army Medical Corps officers, and as testified by the immediate drop in the admission-rate for malarial fevers, which began at once and has continued ever since." Colonel Hodder said: "At the present time (1904), in buildings which were formerly infested with mosquitoes of all kinds, scarcely a sign of one exists; but it has taken two years of continuous work to effect this result." Colonel Nichols gives and discusses many figures, from among which I select the following:

<table>
<thead>
<tr>
<th>Years</th>
<th>Admission-rate per cent.</th>
<th>Years</th>
<th>Admission-rate per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1895</td>
<td>339</td>
<td>1901</td>
<td>575</td>
</tr>
<tr>
<td>1896</td>
<td>417</td>
<td>1902</td>
<td>851</td>
</tr>
<tr>
<td>1897</td>
<td>314</td>
<td>1903</td>
<td>127</td>
</tr>
<tr>
<td>1898</td>
<td>256</td>
<td>1904</td>
<td>77</td>
</tr>
<tr>
<td>1899</td>
<td>141</td>
<td>1905</td>
<td>45</td>
</tr>
<tr>
<td>1900</td>
<td>100</td>
<td>1906</td>
<td>45</td>
</tr>
</tbody>
</table>

The admissions include simple continued fever.

VIII.—CAMPAIGNS AT HAVANA AND PANAMA.

Havana.—I have already referred to the great discovery of the mode of propagation of yellow fever and the subsequent campaign against that disease started in Havana in February, 1901. The result as regards yellow fever was decisive for several years, and

1 Colonial Reports, Annual. Wyman and Sons, London.
although it reappeared in 1905 and 1906 it was again banished when the United States resumed control of the island last year. As regards malaria the general war against mosquitoes in Havana produced marked effects. Almost immediately after the commencement of the operations in February, 1901, this disease also began to decline, and the diminution has been steadily maintained. The details will be found in the full monthly statistics of the "Board of Health," but Dr. Charles Finlay, the distinguished originator of the mosquito theory of yellow fever, and head of the Health Department of Cuba, has kindly furnished me with the following figures of the deaths from malaria in Havana for a number of years:

<table>
<thead>
<tr>
<th>Years</th>
<th>Deaths (malaria)</th>
<th>Years</th>
<th>Deaths (malaria)</th>
<th>Years</th>
<th>Deaths (malaria)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1880</td>
<td>335</td>
<td>1889</td>
<td>228</td>
<td>1898</td>
<td>1,907</td>
</tr>
<tr>
<td>1881</td>
<td>228</td>
<td>1890</td>
<td>170</td>
<td>1899</td>
<td>909</td>
</tr>
<tr>
<td>1882</td>
<td>191</td>
<td>1891</td>
<td>203</td>
<td>1900</td>
<td>344</td>
</tr>
<tr>
<td>1883</td>
<td>183</td>
<td>1892</td>
<td>202</td>
<td>1901</td>
<td>151</td>
</tr>
<tr>
<td>1884</td>
<td>196</td>
<td>1893</td>
<td>240</td>
<td>1902</td>
<td>77</td>
</tr>
<tr>
<td>1885</td>
<td>101</td>
<td>1894</td>
<td>201</td>
<td>1903</td>
<td>51</td>
</tr>
<tr>
<td>1886</td>
<td>135</td>
<td>1895</td>
<td>266</td>
<td>1904</td>
<td>44</td>
</tr>
<tr>
<td>1887</td>
<td>269</td>
<td>1896</td>
<td>450</td>
<td>1905</td>
<td>32</td>
</tr>
<tr>
<td>1888</td>
<td>208</td>
<td>1897</td>
<td>811</td>
<td>1906</td>
<td>26</td>
</tr>
</tbody>
</table>

The population of the city is about 250,000. Dr. Finlay tells me that it has been possible to carry out anti-mosquito work outside the city only occasionally when yellow fever or malaria threatened certain localities. On all such occasions a regular anti-mosquito campaign was started and ordered to be continued thereafter. This great work, due to Gorgas, Finlay, and the United States Government, constitutes an epoch in tropical sanitation.

Panama.—Perhaps even more remarkable is the work of the Americans under Colonel Gorgas on the canal zone of the Isthmus of Panama. As is well known, the attempt of the French to cut the canal through the Isthmus was foiled principally by yellow fever and malaria, and I was told that their effort had cost quite 50,000 lives. The Americans took possession of the works early in 1904, at a time when the mode of propagation and of prevention of both diseases was well known, and they wisely determined to commence their labours with sanitation. Colonel Gorgas, assisted by a capable and enthusiastic staff, was put in charge and attacked the work with knowledge and energy. I visited the place at his invitation in the autumn of 1904 and was a witness of the skill

1 "Informe Mensual Sanitario y Demografico, Habana."
shown in his dispositions. The country is one of the worst to deal with which I have ever seen. Hilly, with a great rainfall, a loose crumbling soil, a luxuriant vegetation, and innumerable small marshes and pools, it was evidently the very stronghold of malaria. Step by step, with the aid of numerous experts and hundreds of workmen, the Americans cleared the forests, drained the pools, and banished the stegomyia. The details and the results will be found in the monthly and annual reports of the work,¹ and in a recent address by Colonel Gorgas.² Put briefly, the results are that in 1906 amongst 5,000 white American employees the total death-rate was only 7 per mille, and of this only 3.8 per mille were due to disease. Last April the daily sick-rate of the total force of about 40,000 people was only 17 per mille. Colonel Gorgas says: "Among 6,000 Americans in the employ of the Commission, including some 1,200 American women and children, the families of these employees, we have but little sickness of any kind, and their general appearance is fully as vigorous and robust as that of the same number of people in the United States." These published statements are fully borne out by private communications from individuals living there. Colonel Gorgas adds: "I think the sanitarian can now show that any population coming into the tropics can protect itself against these two diseases (yellow fever and malaria) by measures that are both simple and inexpensive . . . and that again the centres of wealth, civilisation, and population will be in the tropics, as they were in the dawn of man's history. . . ."

In this great work of Colonel Gorgas and his colleagues, I recognise the attainment of that ideal which was set before me when, ten years ago, I found the zygotes of the parasites of malaria in mosquitoes. I regret only that the honour of attaining it has not fallen to my countrymen, as might well have been the case. But we must none the less congratulate the Americans on the splendid achievement with which they have signalised their entry into the lists of the colonising nations of the world.

IX.—Remarks and Conclusions.

Exigencies of space have compelled me to be very brief in my descriptions of the above campaigns. In addition to them good

work has been commenced in the Andaman Islands, Ceylon, South Africa, Southern Rhodesia, British Central Africa, Sapele (West Africa), and Mauritius (which last-named place I hope to visit shortly on behalf of the British Government). Good work has also been done in connection with many mines and railways in West Africa, but at present details regarding most of these campaigns are not available, or are either too meagre or buried in inaccessible local reports. The excellent anti-mosquito work of Doty and of Weeks and others in the United States, and of the French in Corsica and Algeria, is somewhat outside my province. I should have liked to describe the operations in Greece (which I was able to visit last year), but this will be done much better by my distinguished friend, Professor Dr. Savas. For many papers on the prevention of malaria I must refer to the British medical press, especially to the Lancet, the British Medical Journal, the Indian Medical Gazette, the Journal of Tropical Medicine, and the Journal of the Royal Army Medical Corps.

From all the experiences collected and the discussions carried on during these ten years the following general conclusions are now, I think, beginning to emerge:

(1) For tropical sanitation against both malaria and yellow fever (and probably filariasis) general mosquito reduction is by far the most practical, as it is the most fundamental, method, at least in thickly populated areas. In support of this proposition, originally advanced by Finlay for yellow fever and now by myself for malaria, it suffices to quote the greatest living authority on the prevention of both these diseases—Colonel Gorgas—who for more than six years continuously has been waging successful war against them, not on a small but on a large scale, and not in easy but in the most difficult possible conditions. Regarding yellow fever, he says: 1 "When we left Cuba after the disappearance of yellow fever, we were inclined to think that the results had been obtained principally by the destruction of the infected stegomyia, but further experience at Panama has convinced me that the important element is the destruction of stegomyia generally. I merely mention this as showing how practical work and experience entirely change well-grounded theories." Regarding malaria, after enumerating the various methods of prevention, he says: 2 "By far the most important of these measures is that of destroying the breeding places,

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2 Ibid.
and this is successfully done by surface and subsoil drainage." So many people write on this subject without any real practical experience of it, that we shall do well in future if we listen more attentively to such words as these of Colonel Gorgas.

(2) Prophylaxis by quinine, by screens, and by segregation may be attempted, if possible, in addition to the fundamental measure, but, as regards tropical towns, must be looked upon only as adjuvants to it. As a rule, in the tropics general cinchonisation is feasible only for officials, troops, and bodies of workmen; and screening and segregation can seldom be used except for public buildings and the houses of Europeans. All should be advocated, but there is a distinct danger of wasting on the subsidiary measures efforts and funds which might be more usefully spent on the fundamental one, a thing which I have frequently observed to happen. For example, cinchonisation is being much advocated, and quite rightly so, for the troops in India; but at the same time irrigated fields are often permitted to remain in the close vicinity of barracks. Hence, while the number of relapses among the men may be reduced, yet probably just as many as before become infected from the surrounding untreated population, and a false impression of improvement is given. It is constantly forgotten that for the individual quinine is, properly speaking, not a prophylactic at all—it does not exclude infection, but merely extirpates it (in some cases) after it has effected an entry. It is poor policy to substitute a possible extirpation for a certain exclusion. On the other hand, the subsidiary measures become essential where it is not worth while to attempt mosquito reduction, as in the case of camps and of many isolated houses, farms, plantations, &c.

(3) There is no doubt that the mere knowledge of the fact that mosquitoes cause infection is producing a great improvement of the health of educated people in the tropics. This occurs in two ways: first, such people are more careful in the use of nets; and secondly, medical men, without undertaking formal campaigns, do more than formerly to suppress breeding pools close to houses, barracks, &c. There is thus a kind of unconscious prophylaxis beginning to be adopted everywhere. The following figures, which I have collected from the Indian Sanitary Reports, give some evidence of this:

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Admission-Rates per 1,000 for Malaria in India.

<table>
<thead>
<tr>
<th>Years</th>
<th>1896</th>
<th>1897</th>
<th>1898</th>
<th>1899</th>
<th>1900</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
<th>1905</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaol prisoners</td>
<td>292</td>
<td>383</td>
<td>318</td>
<td>310</td>
<td>364</td>
<td>352</td>
<td>375</td>
<td>366</td>
<td>346</td>
<td>336</td>
</tr>
<tr>
<td>Native troops</td>
<td>292</td>
<td>363</td>
<td>355</td>
<td>277</td>
<td>335</td>
<td>373</td>
<td>286</td>
<td>256</td>
<td>201</td>
<td>180</td>
</tr>
<tr>
<td>White troops</td>
<td>253</td>
<td>420</td>
<td>427</td>
<td>245</td>
<td>321</td>
<td>300</td>
<td>254</td>
<td>247</td>
<td>177</td>
<td>114</td>
</tr>
</tbody>
</table>

These statistics refer to the prisoners and troops of the whole of India, and are, therefore, very reliable. It will be observed that the admissions among the prisoners have not decreased, owing to the fact that these people, drawn from the lowest classes of the population, are constantly being changed in the gaols, so that sanitary improvements as regards malaria in these buildings can produce little effect on their fluctuating population. On the other hand, there appears to be a considerable decrease among the troops, all of whom have medical men in charge of them, while the white troops are provided also with mosquito nets or punkhas. There has been a slight increase in the amount of simple continued fever diagnosed, but not nearly enough to account for the fall in the malaria rate.

(4) But unconscious prophylaxis of this kind will not do everything, and State intervention is necessary if the fullest results are to be obtained. Here two great mistakes have been made.

The first mistake is to suppose that we can educate the general public by means of notices and pamphlets to protect themselves against disease—a mistake constantly made by inexperienced sanitarians. We may reach a few educated people in this way, but, as every practical health officer knows, the masses will not trouble to take the advice. It is ridiculous to suppose, for example, that a large native population will use nets, or take quinine, or destroy mosquitoes, simply because the “doctors” advise them to do so. Even among civilised nations hundreds of thousands reject so simple a precaution as vaccination. In other words, from a sanitary point of view, the general public is a child which must have everything done for it.

The second mistake is to suppose that small local authorities, if left to themselves, will interest themselves greatly in sanitation. A review of the campaigns against malaria which I have discussed will show that all of them are due to the energy and intelligence of single persons. If a locality possesses a governor or a medical man of capacity the campaign is started and is continued as long as he remains there. If not, nothing whatever is done. The truth is simply that local officials are, as a rule, unwilling to take the
necessary trouble. Secure of their pay and their pensions they easily avoid the obligation by pretending that the work is too difficult or too expensive. Now the only way to overcome this inertia is to use official compulsion from the higher authorities. But, strange as it may seem, I have not known a single case in which such action has been taken. The local authorities are allowed to go their own way quite uncontrolled, and are not even compelled to collect statistics. At the same time nothing is done to encourage sanitary officials to bestir themselves in this line. I have not heard of a single instance in which anyone who has really done good work against malaria has received official thanks or reward for his pains; while, on the other hand, honours have been given to men who have actually retarded such work. There is often much pretence of action—conferences are held and speeches are made, but the years elapse and—the malaria remains as it was.

Besides local inertia there is another reason why local efforts against the disease are often so limited, and that is the fact that medical men in the smaller colonies do not always possess the knowledge of how to use the colonial resources to the best effect. Ill-advised attempts are made and result only in failure, waste of money, and discouragement of other efforts.

X.—RECOMMENDATION.

After consideration, therefore, I can only suggest—what I have fruitlessly suggested many times for many years—that the best way to encourage more vigorous action in the future is to centralise the anti-malarial administration. Each principal government which presides over malarious countries or colonies should appoint a special commissioner to travel from place to place in order (1) to advise local authorities as to the best measures for dealing with malaria in each locality; (2) to report to the head government; and (3) to organise the collection of statistics. Such an appointment is perfectly practicable, and is in fact nothing but the specialisation of the Indian system of Sanitary Commissioners or of the American Marine Medical Service system. It would gather the reins of anti-malarial organisation into one hand; would help the willing authorities and stimulate the unwilling; and would save funds now often wasted on abortive efforts. At present, I think, the inhabitants of many malarious places have reason to make serious complaint of the slackness with which modern discoveries have been followed up, and we can only hope that the next decade will show a more rapid advance in this respect.
Ronald Ross

ADDENDA.

Since the above was written the colonial reports, for some West African colonies for 1906 have been published and give more detail on sanitary matters than previous reports have afforded. In Sierra Leone the sum of £2,223 was expended on repairs to streets and on laying down concrete surface drains, and a scheme "for devising a proper system of drainage has been approved by the Secretary of State and will be carried out during the current year." The mortality and morbidity returns, as briefly given in the report, show no marked change during recent years. For Bathurst, British Gambia, it is stated that, "Bordered as it is on two sides by large swamps, there must, however, be a great deal of fever endemic in the place, and this it is impossible to prevent, though considerable improvement has been effected by the anti-mosquito sanitation measures which are vigorously prosecuted." In the report for the Gold Coast it is stated that "improvements were carried out at considerable expense in the towns of Cape Coast, Sekondi, and Kumasi." The Deputy Principal Medical Officer states: "I have no hesitation in saying that the health has improved," but I can find little trustworthy evidence of this in such figures as are given in the colonial reports. Work done in Burma has already been mentioned, but further details will be found in Colonel King's report on the sanitary administration of Burma for the year 1906, showing that active interest is now being taken in the matter.

Regarding the Federated Malay States, there was a great increase of malaria during 1906 in the district surrounding Klang and Port Swettenham, owing to a large influx of coolies, but in these towns themselves it has remained absent owing to the measures taken (supplement to the Selangor Government Gazette, 1907). Dr. M. Watson is urging energetic measures for dealing with the malaria of coolies in plantations. Great interest is shown in the country regarding the whole subject, and the medical department is happy in having the strong support of the British Resident, Mr. Conway Belfield.

At the meeting of the British Medical Association in July, Major A. H. Nott, I.M.S., described an anti-mosquito campaign at Mushedabad in India, but I regret that I have not yet been able to see a copy of his work.

Owing to the efforts of Colonel Seely, M.P., and Mr. Hahne-

1 "Colonial Reports, Annual." Wyman and Sons, London.
mann Stuart, the British Colonial Office promised last year to issue a report on the prevention of malaria in all the colonies in its jurisdiction, but the paper has not yet been published.

As many shipowners have taken interest in tropical medicine, I sent a circular some months ago to most of the leading firms with sailings to the tropics, asking them for information regarding the steps which any of them may have taken to prevent malaria on board their ships. Although the request was repeated, only three firms have replied. The Booth Steamship Company (Liverpool, New York, and Brazil), which has done much for research work, informs me that quinine is given regularly to its crews while on the Amazon, and that the men are provided with mosquito nets and the ships' hospitals with wire-gauze fittings. They have few cases of fever. The Harrison Line (Liverpool, America, South Africa, and India) has never had many cases of fever on board its ships; but nevertheless quinine is given regularly "at malarious ports," and the men are supplied with muslin mosquito-bars. Messrs. John Holt and Co., who charter steamers to various tropical ports, strictly order the use of quinine and provide mosquito nets and sun-helmets for the men. Mr. Holt says that "the general effect of our instructions has been to lessen fever arising from malaria," but is disappointed that it has not been entirely banished. He is not a shipowner, but wishes that some owner would build (experimentally) a steamer fitted for excluding mosquitoes, and cannot conceive that such a thing is impossible to human ingenuity. He thinks that legislation should be passed to compel vessels visiting the tropics to adopt the necessary measures against malaria.