

(January 17th, 1916.)

Sanitation in Panama.

BY SURGEON-GEN. WM. CRAWFORD GORGAS*

AT a regular luncheon of the Club held on the 17th January, Surgeon-General Gorgas said:

Mr. Chairman, and my hosts of the Canadian Club,—In the last few days, since coming to Canada, I have been very much impressed with the constant references to the war in Europe, and the evidence that the questions raised by that war are in the thoughts of everybody, and nearly everyone I have met has had some relative in the Army, and frequently there have been losses in the families of the people I have been coming in contact with. That has brought the war very forcibly to my mind, and I feel rather apologetic in wanting to speak on a question like Panama to people whose thoughts are so seriously engaged. But as most of my knowledge concerning sanitation was gained in Panama and other tropical regions, I will make that my apology for bringing the subject before you this afternoon.

I am coming around after a while to sanitation in Panama, but if, in the meantime, I talk about the beginning of things, don't think I have forgotten about Panama, no matter how far I seem to be wandering.

Sanitation has had a great deal to do with the history and the peopling of the world. While historically we cannot go back to the original home and beginning of the white man, I think we can argue from conditions as we see them what this beginning must have been. We of all animals are less naturally provided against cold than any other. Man, particularly the white man, with his hairless body, must have come to his present state of mental and physical development somewhere in the tropics; he could not have survived in the temperate zone. Man in such weather as this could not have survived a single winter, nor could he in Washington, nor even in Alabama. So his original home must have been somewhere in the tropics. Life there was so easy that he stayed in tropical countries as long as he could, until forced out by some cause.

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All species of animals must have come to their present stage of development when the earth was somewhat cool; necessarily, also, their origin was in a very temperate area. Now malaria is caused by an animal parasite, which is, as far as germs go, of a very high order, so high in the scale of animal life that it is sexual. As we know the germ now, it is entirely dependent upon man and the mosquito for its life history, for its propagation. This has rendered its life more or less precarious compared with other animal matter, with its high order of intelligence and the ability to move around and get food everywhere. Therefore, even if the malarial parasite did get to its present stage of development as early as man did, it would have taken a long time to move, say, from one continent to another.

It is evident that when man came to his present development, mentally and physically, he was living in the tropics, in perfectly healthy surroundings; it was his natural condition. What probably drove him out was the disease of malaria which finally struck this Eden in which man was living, very probably inhabiting half a continent. When malaria invaded that part of the tropics, health conditions became just as bad as at present, and so far as the white man went, the country was just as uninhabitable.

Man, therefore, had to face extinction, or get out and move north. In his then physical condition he could not live in the temperate zones; they were as unhygienic to our ancestors as the tropics are to us now. Take a naked man, with no knowledge of fire, and he could not get very far north until the unsanitary condition of cold caused his extermination. About this time, the fact that they were facing extermination sharpened the wits of our ancestors, and some great sanitarian, twenty, thirty or fifty thousand years ago, discovered fire. Clothing from skins of animals was, it seems to me, more naturally an early development. And when these two great sanitary measures had been discovered by man, he could then inhabit regions to the north. Then gradually, in the course of years, he moved into Europe.

He moved much farther than he needed because of malaria. History shows that malaria affected Egypt, the whole Tigris valley, Mesopotamia, Greece and Italy. It came there within the history of man. I don't know that one could prove it historically by any arguments, but it is self-evident, I think, to anyone who will study the matter that such large armies as camped and moved around readily in Babylonia could not have done so if conditions there were then as they are at present. We know, too, that Greece could not have flourished

as she did if malaria had been present there as it is now. When the country became thickly settled, malaria began to spread, and has been rife there for fifteen hundred years. So it seems to me that malaria is a comparatively recent disease in its spread through the tropics.

Now I have gotten our ancestors to Europe, with malaria following them very closely. Panama is still in the distance. (Laughter.)

Our ancestors lived very contentedly and happily in Europe until the discovery of America. About the time that Columbus lived a great expansion of knowledge of geography occurred. Then the Europeans began again to seek the tropics. Up to that time there had been no great migration from Europe to the tropical regions. But when this discovery was made men went to the tropics in great numbers. They soon found however, that man, especially the white man, when he went to the tropics, died; those who survived did so with broken constitutions. It was even worse for the women and children, and for any settlement of people to remain in the tropics, there had to be constant renewals from home. Therefore, man very naturally concluded that the tropics were uninhabitable for people of the white races, and that this was due to climatic conditions. In this I hope to point out he was mistaken; the cause was infection, not climatic conditions.

For three or four hundred years, then, infection prevailed, and the white man has made no serious attempt, up to the present time, to colonize in the tropics as we have in North America, with an entire population actually tilling the soil and cultivating the country.

Taking the tropics in the western hemisphere, the two diseases that caused most of this trouble were yellow fever and malaria. About the year 1880 a distinguished French army surgeon discovered that malaria was due to a polyp, a small parasitic germ, which got into the blood, poisoning the blood with its excretion. A very short time after this, an English physician, Sir Patrick Manson, discovered that the tropical disease of malaria was conveyed from man to man by the mosquito. Eighteen years later, Sir Ronald Ross and his co-workers discovered that malaria was conveyed by the female anopheles mosquito.

Now, it is only the female of a certain species, one of the six or seven hundred species of mosquito, that bites man and then injects the malarial poison into his blood. Our tropics were scourged by another disease much more fatal than malaria, and after our Spanish-American war, Walter Reed, a United States Army surgeon, discovered that yellow fever is

transmitted by the female of another species of mosquito, in the same way.

You notice I say the female. Of the six or seven hundred species it is only the female that ever bites; the male is harmless in that respect. (Laughter.) It is not so much from his good nature as from the fact that he has not the biting organs. The principal food of the mosquito is the saccharine matter of various vegetable juices, and it is to get the food of these that the female seeks blood. In captivity, she will not begin to lay until she has gotten a rich meal of blood; it stimulates her nutrition. Any blood will do, and the rich blood stimulates her nutrition up to the point of laying.

Now, I am glad I have gotten you, not quite to Panama, but to Cuba, where we first noted malaria and yellow fever with reference to the mosquito. The female of the *stegomyia* species of mosquito is ordinarily the only means of conveying yellow fever. In order to become infected, she has to bite a man who is sick of yellow fever; she becomes infected if she bites him in the first three days of his disease,—after that, she is not infected. Then after swallowing the parasite in this way, she has to remain from twelve to twenty days before she herself can transmit the disease. After she is thus infected, if she bites a man who has not yet had yellow fever and is non-immune, this man will develop the disease in not less than three days, and not later than six days, that being the period of incubation. These are all important sanitary points. Reed did a good deal of other experimenting which is very interesting from a scientific point of view, but I have not time to go into the details. Elaborate preventive measures followed through these discoveries, and these sanitary measures have since been used in various parts of the world.

From the fact that yellow fever can be conveyed only by a mosquito, and only during the first three days of sickness, it is clearly necessary to put all sick men under such surroundings that they could not be bitten by mosquitoes. If you can get hold of all the sick men as soon as you can find any signs of the disease, and put them in screened hospitals, you can watch them. To accomplish this required a good deal of machinery in Havana, a city of 250,000 inhabitants. It is a strange fact that natives of a place where yellow fever is endemic are not attacked by the disease; only Americans and Englishmen and Spaniards could have it. There were only two or three thousand of this non-immune class, so we only had to observe these persons. Our inspectors saw every non-

immune in Havana every day, and they were taken care of if there was any sign of their being sick.

Everyone who has had experience knows that no measure carried out by the authorities can be perfectly worked out, so, therefore, we had to fall back on our second line of defence. With this object in view we fumigated all houses where yellow fever was likely to go and all contiguous houses, the object being to kill all the mosquitoes that might have gone to these nearby houses. Remember the scientific fact which I have pointed out, that we had from twelve to twenty days in which to use this precaution. We could do the work pretty thoroughly in twelve to twenty days.

But even this method was not always successful. The *stegomyia* scarcely ever left the spot in which she was hatched. All species of mosquitoes differ in their habits, and enormously in their power of flight. The *Culex* will cover in its flight twenty miles in a night, but the *stegomyia* never leaves the house in which she was bred. The fact gave us an enormous advantage; we knew the *stegomyia* would be found in the house in which she was bred, or in some contiguous house. So by screening rapidly these buildings at public expense, having stations where the working materials were kept, we had an organization whereby within an hour after the discovery of a case a squad of men would be at work screening.

The multiplicity of details would not be interesting to a general audience of this kind, but if any of you expect to have to deal with malaria or yellow fever, I would advise you to look it up in the records of our experience in Havana.

Even these strict measures could not be entirely effective, so we had still a third line of defence, and it turned out the greatest and the strongest of all. We endeavored to kill all the mosquitoes in these districts, and that was really the cause of all our success. This line of work was principally relied upon everywhere, for the control of malaria and yellow fever depends upon the extermination of all mosquitoes. The life history of the mosquito shows that all mosquitoes have to have water in which to lay their eggs; the larva, which is hatched out in from two to three days, has to get its food in water, and it remains there from nine to twelve days. It can remain in any puddle of water, any receptacle will breed mosquitoes, and little puddles in the yards, pitchers and utensils to keep water in the houses, cisterns and rain water barrels in which to get water from the eaves of the dwellings for drinking and domestic purposes, any general water supply, and most of all gutters.

A system of inspection was made out by which all houses and yards were inspected monthly; we adopted also the circulation of public bulletins, explaining to the people how to care for themselves, and that it could be proved that they were wholly responsible for mosquito breeding; that they should get rid of old tin cans, puddles, and everything around that could afford a breeding-place for mosquitoes; that this stegomyia larva required only a pool or puddle around the house, and that the owner of the house would be held responsible where any such were found.

Malaria treatment is a little different. Malaria is carried by a country mosquito, which breeds more in large clear streams, where she is the food of fish. So the measures are a little different which we had to adopt. Principally, it was a question of drainage by open ditches. In Toronto, it would be a very easy task, but for us, it was a very expensive system. In two weeks the grass would be a foot high along the edges. The grass is an attraction for the larva as a protection against the fish. The larva could not live if it were in a ditch to which the fish have access. So these ditches had to be cleaned out every two weeks. If the ditch could be permanently clear, as where you can have a concrete ditch, you can always keep down the mosquitoes, for the fish can always get at the larvae. But we had to attend to that ditch during the whole summer. It was still better if conditions were suitable for putting in a subsoil drainage system of earthenware tiles. Where we could run horse-mowers and cut the grass by machinery, we could clear up a space of 200 yards wide; the anopheles could not generally cross that. A house that distance from their breeding spots or their shelter would be comparatively safe. Cutting by hand over a hundred square miles was an enormously expensive process, but the horse-mower could be put on the same ground, which was a much cheaper method. By such measures we could keep down the grass. Every measure was used in our mosquito killing, but I have not time at present to go further into that, for there is a more interesting subject I want to pass to.

Where these anti-mosquito methods were put into effect in Havana, before and up to February 1, 1901, yellow fever rapidly disappeared. A few months after, in May, 1901, it came again from outside infection, but by September of that year practically the last case of yellow fever occurred in Havana, and so far as practice goes, no case has occurred since (applause), although Havana had had yellow fever continuously up to that time for the previous hundred and fifty years, and had been the point which had infected all the North

American hemisphere. For the disease came across the Carribean Sea and into Canada—because Canada has had yellow fever—and it also went to England, France and Spain very extensively. But every part of the world was infected apparently through Havana. Since its disappearance from that city, these other regions have been free from yellow fever.

Much the same effect has been produced upon malaria. About ten years ago, in 1904, the United States undertook the construction of the Panama Canal. Yellow fever had been very prevalent, but the same methods were applied, with the same results as in Havana, and the last case of yellow fever occurred in Panama in 1906. None has occurred there since, while malaria has been reduced to such a point that it did not interfere with the working of our forces. From a maximum in 1906 of 820 cases of malaria, admitted to hospitals from every thousand of our employees, it was overcome to such an extent by 1913 that it had been reduced to fifty or sixty cases. (Applause.)

We were very much gratified at being able to protect our working forces at Panama, and from a scientific point of view, the matter has attracted attention all over the world.

But I do not think that the most important phase of the sanitary work at Panama is the fact that we protected our workmen; I am inclined to think that this knowledge which is now spread all over the world that man can, at very little cost, protect himself from these diseases of the tropics, will very rapidly become common knowledge.

Now, I make the statement that man can protect himself against the diseases of the tropics from the fact that during ten years of our construction we had ten thousand Anglo-Saxons, men, women and children, away down in this most unhealthy point in the tropics, without any injury to their health or comfort. During those ten years these people were really in better health at Panama than they were at home. I won't stop to explain that. All I want to emphasize is that they were in as good health as at home, in a place in the tropics where for four hundred years before white men were thought to be unable to live, and white women and children could not survive. We protected our people from infection in the tropics; the climatic conditions were exactly the same as they had been during the previous four hundred years. Therefore, it seems to me it needs no further proof that it is not climatic conditions that render the tropics unhealthy for white men, but infections.

Now, I think we are at the turning point, and that when

this knowledge becomes general, we will again go back to the tropics, which I have been arguing was our original home; and these discoveries of the method of the transference of yellow fever and malaria are going to have the effect of getting us back to this Garden of Eden from which we were ejected fifty thousand years ago by the anopheles mosquito, and that we will again flourish there as we no doubt flourished fifty thousand years ago. (Laughter.) The attraction will be very strong, from the fact that we can live there very much easier, for one horse-power of energy applied will produce very much more wealth in the tropics than here.

We are accustomed to look upon ourselves as in our natural habitat, and upon the tropics as being an unnatural abode. Mankind has got used to wearing clothing, covering his body, living in houses, being warmed by fires, and living under very artificial conditions as compared with what must have been the conditions of our original development. No doubt man, if he would again thicken his skin, might be much stronger and healthier, mentally and physically, for he has survived even with his body and the glands of the skin covered. So it is possible that all the population may go down some time to the tropics again. A great civilization will, no doubt, spring up there, and great science and culture, it may be of the highest type, be developed down there in the valley of the Amazon. And our descendants may return to the costumes that were used fifty thousand years ago; they may dress again in the clothing of the gentlemen of that period, and the mark of highest fashion will be a highly decorated breech clout with a pair of sandals. (Laughter.) I think it is quite possible that it is not fashion altogether that has caused us to wear clothing, but that friction against the skin was the original idea; then, as people four or five hundred years after having adopted this custom still followed it, the fashion became established. I am looking forward two or three thousand years. At the time the custom was acquired, they were living in the temperate zone, but we may have different ideas when we get back to the tropics. I am not speaking, however, with any personal bias (laughter); I don't believe at my time of life and with the figure I possess at present that I would care to appear in the handsomest breech clout, and the handsomest pair of sandals (laughter), but a younger man might think differently.

It has been a very great pleasure for me to meet this society, and have the opportunity of riding my hobby to the extent to which you have allowed me to do so to-day, and I thank you for your courtesy and attention. (Applause.)